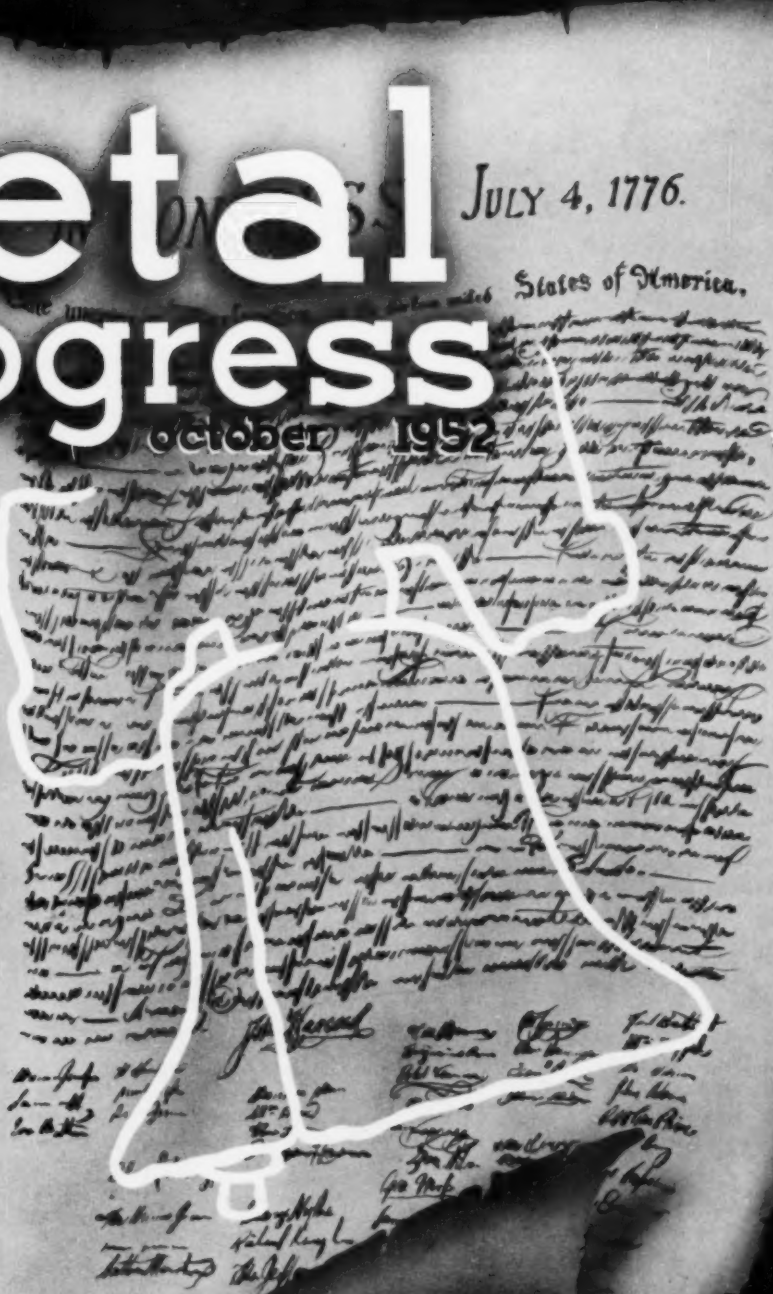
metal progress

October 1952



NATIONAL METAL CONGRESS and EXPOSITION

PHILADELPHIA OCT. 18-24

*high production UNIFORM RESULTS WHENEVER Surface ROTARY HEARTH FURNACES ARE USED!

Typical of the jobs being done by 'Surface' Rotary Hearth Furnaces

•

GAS CARBURIZING AND GAS CYANIDING

AUTOMOTIVE TRANSMISSION PARTS

Production—612 lb/hr., net
Temperature—1550 F.
Firing System—Radiant tube—natural gas
Atmosphere—RX-enriched (plus ammonia, for cyaniding)
Hearth Size—12 ft. outside diameter

•

NON-FERROUS METAL FORGING

BRASS AND COPPER BILLETS HEATED FOR EXTRUSION

Production—24,000 lb/hr., net (9 in. diameter billets)
Temperature—1650 F. maximum
Firing System—Direct-firing burners—natural gas
Atmosphere—None required
Hearth Size—31 ft. outside diameter

•

HARDENING

AUTOMOTIVE RING GEARS

Production—210 lb/hr., net (16 in. O.D. ring gears, 35 lbs. each)
Temperature—1650 F.
Firing System—Direct-firing burners—natural gas
Atmosphere—None required
Hearth Size—5¾ ft. outside diameter

•

PROJECTILE NOSING

155 MM. HIGH EXPLOSIVE PROJECTILES

Production—50-60 pcs. 1 hr.
Temperature—1900 F.
Firing System—Single down-firing variable flame burner
Atmosphere—None required
Furnace—Rotary case—11½ ft. diameter

*It's in the records of many prominent companies with mass production schedules—versatile 'Surface' Rotary Hearth Furnaces measure up to the job with *profitable results.* The experience of Ross Gear & Tool Company, Lafayette, Ind. is typical. Here, the clean hardening of steering arms and lever shafts is required.

A 'Surface' Rotary Hearth Furnace equipped with radiant tubes and an RX prepared gas atmosphere does the job. Steering levers and shafts—*1,000 lbs. every hour*—are uniformly clean hardened. The furnace operates 24 hours a day and during two years of continuous service, has never been down for repairs. Only one operator is required for the operation.

For controlled atmosphere or direct-fired heat treating processes, it will pay *real dividends* to check the outstanding advantages of 'Surface' Rotary Hearth Furnaces in your production picture.

Write today for bulletin and for the full story on Ross Gear & Tool Company's experience.

SURFACE COMBUSTION *Corporation*
TOLEDO 1, OHIO

'Surface' INDUSTRIAL FURNACES AND BURNERS
Kathabar HUMIDITY CONDITIONING SYSTEMS
Janitrol AUTOMATIC HEATING EQUIPMENT

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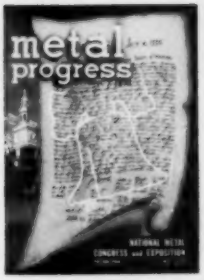

Floyd Craig, *Metal Progress*'s art director, made a cover appropriate to the site of the annual meeting of the Society, to which this issue is largely devoted

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A YEAR ROLLS around very rapidly and now we are only a few days away from the opening of the 34th Metal Congress and Exposition. One year ago we were in the midst of receiving the overseas conferees and completing plans for the conduct of the first World Metallurgical Congress. This outstanding event is still vivid in the memories of all and probably will be for quite some time to come, or at least until the second World Metallurgical Congress—in Europe in 1955 or 1956—produces a brighter and more scintillating memory.

But here we are all ready for the Metal Congress and the greatest Metal Show in history, which give every promise of living up to the slogan, "Metals Keep the Peace", and will present some of the most important technical achievements in years. Again the A.S.M. is pleased to have the cooperation of three other national technical societies, sponsoring extensive programs in their various fields of activity.

The Big Metal Show this year will be beyond comparison and it will remain the largest annual industrial exposition in America. Soon after the assignment of spaces the entire capacity of the four large convention halls in Philadelphia was sold out. It is going to be a Show and a Congress that you will not want to miss because of the great number of unusual features, beginning with the ever-popular seminar on Saturday and Sunday preceding the opening of events on Monday.

For the first time in the history of the Metal Show the royal guests and visitors will tread upon a royal carpet. Some 4500 sq.yd. of foam-rubber-backed carpet will be unrolled down the aisles for the comfort of the visitors. The decor for the Exposition is going to be different than ever before. You will get a thrill out of seeing the progress in products made from metals. There will be a tremendous number of exhibits you will want to see and examine, and fine technical papers you will wish to hear and discuss. Therefore, you should make plans to attend this 34th annual Congress and Exposition.

If there is any one thing that I believe "there should be a law about", it is that all new members of the A.S.M. should be required to attend the first convention and exposition of the Society that occurs after their election to membership. Those who attend always return to their jobs with new ideas, new vim, new pep and vigor that is worth a hundred times more than the cost of the trip. The A.S.M. convention gives them a tremendous, broad outlook covering education, business and the Society.

The metal-producing and metal-fabricating industry is the largest employer of engineering talent in America. In fact, the metals industry constitutes 40% of the national economy ($152 billion); the next largest are foods (10%) and textiles (9%). Consequently, the A.S.M., the Engineering Society of the Metals Industry, is constantly engaged in an endeavor to raise the descending enrollment in engineering schools. One way in which the Society hopes to accomplish that purpose is to have all the students in all engineering schools within bus ride of the Philadelphia Convention be the guests of the Society on Friday, Oct. 24.

It is sincerely hoped that in this way the mechanical, electrical, aeronautical and all of the students in various branches of engineering will be brought into close contact with the metals industry. They will be given an opportunity to get an insight into the industry and to talk to manufacturers who can offer promising opportunities to these young engineers upon graduation.

I'll be seeing you in Philadelphia.

Cordially yours,

Bill

W. H. EISENMAN, *Secretary*
AMERICAN SOCIETY FOR METALS

RETORT SERVICE LIFE INCREASED 30%

Aetna Ball and Roller Bearing Company produces a wide range of ball thrust bearings for all industry.

...when cast in THERMALLOY*

When you want longer service life from your heat treating parts . . . Thermalloy can be the answer. That profitable point was proved at the Aetna Ball and Roller Bearing Company in Chicago, Ill. This company found that *retort service life increased 30%* when cast in Thermalloy.

Shown above are workmen at the Aetna plant removing a batch of ball thrust bearing races from a Thermalloy retort. At this point, the temperature is normally 1750°F., with the heat treating cycle lasting about 5 hours. In operation 24 hours a day, service life of these Thermalloy retorts averages around 10,000 hours with some going full blast to nearly 15,000 hours.

Designed by Electro-Alloys engineers, the shape of this octagonal Thermalloy retort provides Aetna with a sounder casting that gives more uniform tumbling action with less marring of parts.

For retorts, furnace parts, trays, racks, pots, muffles—Thermalloy gives you more operating hours per dollar. Our engineers will help you select the right grade of Thermalloy, engineer the casting and foundry practices necessary to produce a high heat-resistant casting for lowest cost service life. Call in an Electro-Alloys engineer for full information or write Electro-Alloys Division, 2103 Taylor Street, Elyria, Ohio.

*Reg. U. S. Pat. Off.

AMERICAN Brake Shoe COMPANY

ELECTRO-ALLOYS DIVISION
ELYRIA, OHIO

"ROCKWELL" HARDNESS TESTERS

See them in Action!

J-Model "ROCKWELL" HARDNESS TESTER

at the

NATIONAL METAL SHOW

•

Philadelphia • Oct. 20-24

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BOOTH 706

TUKON TESTER for MICROHARDNESS TESTING

See how easy it is to be sure of the hardness of metals you process—by using WILSON Hardness Testing equipment.

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"ROCKWELL" HARDNESS TESTERS

MECHANICAL INSTRUMENT DIVISION
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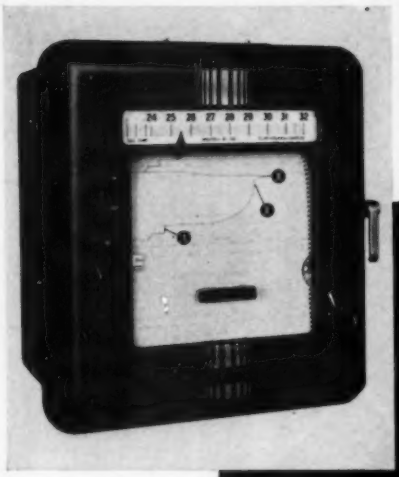

Significant points on chart of Speedomax Immersion Thermocouple Recorder at left are: (1) standardization of recorder circuit during couple immersion; (2) temperature of steel bath, and (3) increase in thermocouple temperature during withdrawal through slag. Entire measuring sequence is swiftly recorded by Speedomax in less than one minute.

In the illustration below, an operator plunges an L&N Immersion Thermocouple, connected to a remately-located Speedomax Recorder, into the steel bath . . . withdraws it as soon as the Recorder signals that temperature measurement is complete.

Important Speedomax Feature

guards accuracy

of Bath Temperature Measurements

• Now the L&N Immersion Thermocouple Recorder standardizes itself during each measurement . . . helps assure quick, accurate use of immersion thermocouples in measuring temperatures of molten steel.

Occurring only *seconds* before the thermocouple reaches maximum temperature, this adjustment eliminates variations resulting from ambient temperature changes. And since standardization is completely automatic—initiated by each immersion of the couple into the steel bath—the operator is freed of responsibility for this critical detail.

This simplicity characterizes all steps in using the Speedomax Recorder and Signal System for immersion measurements. Signal lights at the furnace, remotely operated by the Recorder, indicate whether the immersion equipment is operable, and warn when bath temperature is reached. Each immersion then results in a significant measurement—and minimum exposure to the high temperature prolongs couple life.

Used with the widely-accepted L&N Immersion Thermocouple, or with *any* immersion couple, the Speedomax Recorder and Signal System promotes improved immersion techniques and reliable measurements . . . results in reduced cost per reading.

For details, write us at 4927 Stenton Ave., Philadelphia 44, Pa., for Folder N-33-640(1), "Measure Bath Temperatures Effectively", or contact your nearest Leeds & Northrup representative.

CAREER OPPORTUNITIES AT L&N

Expansion program of this long-established firm has many features to attract outstanding recent graduates in engineering and science. Opportunities are in sales field engineering, product and application engineering, research, advertising, market development. Widely-respected policies assure recognition of progress and achievement. Address Personnel Manager for preliminary interview at nearest of 17 L&N offices.

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LEEDS NORTHRUP

INSTRUMENTS
AUTOMATIC CONTROLS
FURNACES

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Continuous
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DREVER

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No one knows your production problems as intimately as you do. But Houghton on-the-job Service can often add something to your experience that will result in a quicker and more satisfactory answer. This on-the-job Service is rendered right out in your shop by your Houghton Man. He is constantly meeting up with a wide variety of problems as he is called into metalworking plants. You not only get the benefit of his extensive experience in getting to the crux of the problem, but back of him is the Houghton organization with 80 years of research and development work. If he doesn't know the answer—he'll get it from our technical staff. Have your Houghton Man take a look at your metalworking operations. A lot of plant managers are finding that this simple step brings surprising results.

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Ready to give you on-the-job service . . .

ATION'S LARGEST
AGNESIUM
AND CASTING

is this 1630 lb. giant, being produced by Rolle after other magnesium foundries said it couldn't be poured in one piece. This mammoth casting, forming the base of a military electronic unit on which smaller, 550 lb. magnesium sting will rest, is being duced in quantity for the stern Electric Company. ntire 2-piece unit weighs an a ton—about 1 5 ght if made from steel. the Metal Show!

Both castings—base and revolving part of electronic unit—are light enough to be handled by a one-ton truck . . .

SEE YOU AT THE METAL SHOW IN PHILADELPHIA

This unique magnesium casting will be on exhibit at our **BOOTH No. 750**

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your thinking about

MAGNESIUM CASTINGS

Take advantage of Rolle know-how and imagination to get the extra strength/weight benefits magnesium offers . . .

If *saving weight* will give your product *extra* advantages, investigate the benefits magnesium—and Rolle—can give you. And while you consider your design problems in the light of these benefits, don't limit your thinking to what has already been done. We'll cast anything you want in magnesium!

The record size magnesium sand casting pictured—a 10-foot giant other foundries claimed couldn't be cast!—is a typical example of Rolle skill and imagination put to work in accomplishing "impossible" jobs.

Let's say your design calls for ultra-light magnesium castings; whether big or little, simple or intricate, just why will it pay you to specify Rolle? Here are 5 good reasons:

1. *PIONEER KNOW-HOW.* You'll benefit by Rolle know-how that stems from our pioneering in the development of magnesium castings—knowledge that extends from design to the finished casting.

2. *COOPERATIVE RESEARCH.* You'll be aided by extensive research that includes the application of more than a dozen highly successful magnesium alloys—including the new RZ5, Z5Z and ZRE; magnesium zirconium alloys now being specified for aircraft structural and jet engine production.

3. *COMPLETE LABORATORY CONTROL.* You'll get the advantages of Rolle's up-to-date controls which guarantee precision, tensile strength, high temperature properties and other metallurgical quality factors—from scientific sand control to our new Applied Research Quantometer making rapid pre-pouring analyses of alloys while still in the melting furnace.

4. *DESIGN HELP.* You'll share Rolle's vast fund of information on designing with magnesium—the result of working closely with design engineers through the development stages of this increasingly popular light metal.

5. *WIDESPREAD SERVICE.* Rolle foundries—largest magnesium casting facilities in the East—offer you the skill and experience needed to turn out magnesium castings in any quantity, to practically unlimited specifications, from featherweight "midgets" to parts weighing thousands of pounds.

It will pay you to talk over your design and production problems with a Rolle representative. Let us show you how magnesium sand castings can be applied to make your product better; how to chop ounces, pounds, even *tons* off the weight of your product without sacrificing strength or durability; and how they make many operating economies possible in the plant.

MANUFACTURING COMPANY, INC., Lansdale, Pa.

Magnesium and Aluminum Permanent Mold and Sand Castings

SHORTEST ROUTES to new

Outstanding DYNALOG* Electronic Recorders and Controllers

Dynalog Controller

The extreme simplicity of Dynalog Electronic Instruments results in unmatched accuracy, sensitivity, and speed — plus unequalled freedom from maintenance. Designed to take full advantage of electronic circuits, these instruments provide completely stepless, continuous balancing. Full-scale to complete balance in as little as one second (3 seconds, standard). Dynalog is the only potentiometer that has:

NO SLIDEWIRE **NO GALVANOMETER** **NO STANDARDIZING**
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INDICATORS, RECORDERS AND CONTROLLERS Available for temperatures up to 2800°F. with thermocouples, and up to 600°F. with resistance bulbs; for pH with Beckman electrodes; for blast air moisture with the Foxboro Dewcel; for force cells and weight cells. Controllers supplied with either pneumatic or electric control systems. For on-off, proportioning, or automatic reset control.

The Multi-Record DYNALOG

Measures and records a point every 6 seconds — up to 6 different points — in 6 distinctive non-blurring colors. The single pen arm positively synchronizes all records in respect to the time arcs on the chart. Records are easy to read; the circular charts are economical and convenient to file.

Multi-Record Dynalog

The Segmental Chart DYNALOG

Records 24 points on one chart at one minute interval per point. 24 points in 25 minutes. Economical for supervisory records on a large number of slowly changing temperature points such as furnace walls and roofs, bearings, etc.

*Reg. U. S. Pat. Off.

RECORDING • CONTROLLING

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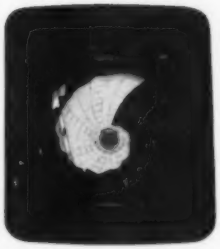
ECONOMICAL TEMPERATURE CONTROL for furnaces and ovens

Top performance of the Type 4000 non-recording controllers has been proven over many years of service. A single motor can operate up to 5 instruments . . . affords large savings in both initial and operating costs. Control is electric . . . action, on-off or proportioning.

Type 4000 Non-Recording Controller

SCHEDULE CONTROL for repetitive time-temperature cycles

When used with Type 4000 controller, this time-temperature comsetting unit varies control point to carry out any program. Different rates of rise, holding periods and other variations can be combined on the same cam. Mechanism is extremely simple and trouble-free. Aluminum cam blanks, printed with time and temperature scales, are easy to lay out and cut.



Program Controller

STRONG ACID PICKLING with the Type 4000 non-recording temperature controller

Simpler, fewer, larger, and more rugged parts make the Type 4000 particularly free from maintenance problems and expense. The electrical measuring system permits controller to be located any distance from bath, away from corrosive atmosphere.

Foxboro strong-acid thermocouples stand up in severe pickling solutions. Reduce maintenance costs and interruptions in service.

FUEL, AIR, AND WATER PRESSURES

With Foxboro pressure indicators, recorders, or automatic controllers; gas or oil pressures for furnace burners can be maintained efficiently . . . compressors and hydraulic systems controlled accurately . . . steam pressures properly indicated or recorded . . . and many similar functions performed to streamline costs. All standard ranges between 1" of water and 80,000 lb.

Pressure Recorder

FLOW OF FUEL, AIR, WATER, STEAM

Foxboro Flow Meters accurately record flow to show plant, department, or operation consumption of gas, oil, steam, water, or air. For operating pressures up to 5,000 lb. Can be equipped with integrators to totalize flow. On many processes, pressure or temperature records can be combined on the same chart with the record of flow. Also available: automatic flow controllers.

Flow Meter for Fuel, Air and Water

ELECTROPLATING TEMPERATURE CONTROLS

Accurate, automatic control of heating or heating and cooling in plating tanks, cleaning baths, degreasers, and wash tanks by this compact instrument assures top quality at low cost. The Foxboro Model 41 meets the demand for an inexpensive indicating controller that gives unexcelled performance. Bulbs of Type 316 Stainless Steel, to resist corrosion and eliminate maintenance, are standard.

Model 41 Temperature Controller

✓ **Check all the features of these instruments for help in bringing maximum economies to your plant. Write for complete data. The Foxboro Company, 5210 Neponset Ave., Foxboro, Mass., U. S. A.**

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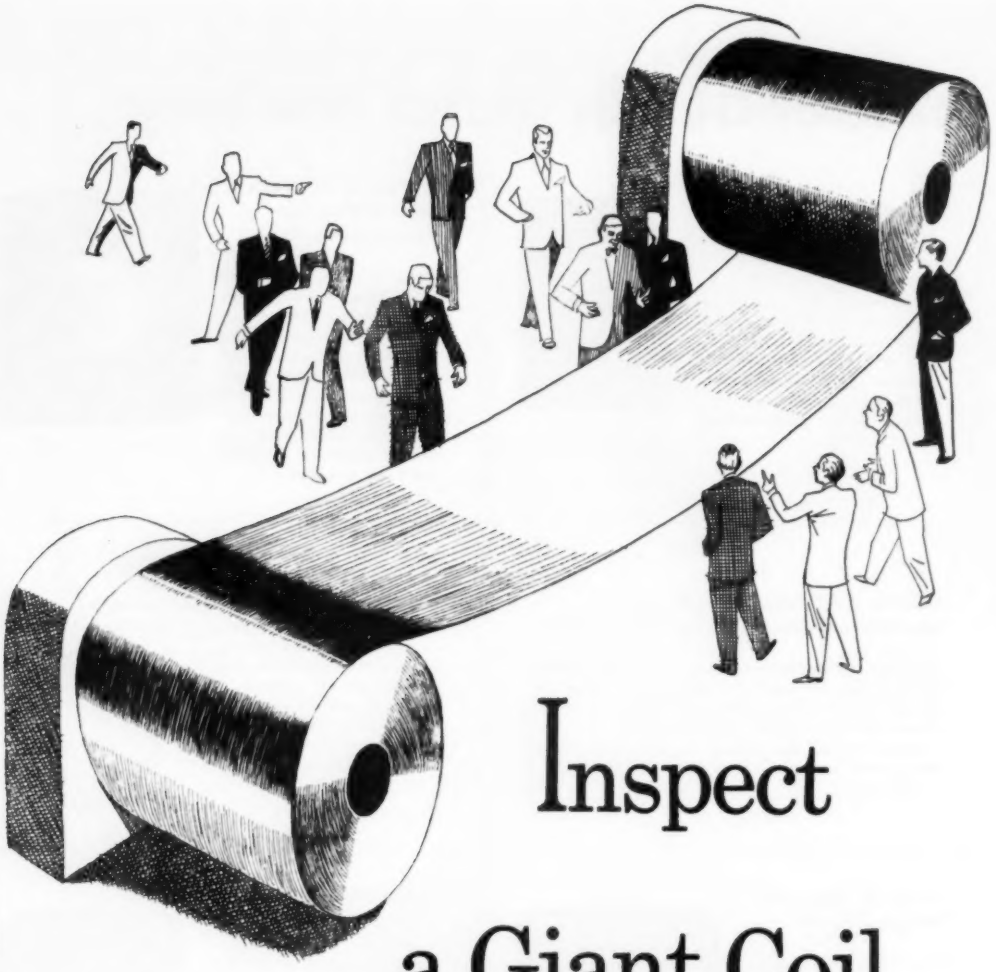


Inspect a Giant Coil of Brass

See why SCOVILL CONTINUOUS-CAST BRASS STRIP brings to fabricators greatest inherent soundness and uniformity...

Commemorating 150 years of craftsmanship in metals—Scovill presents in action its early hand method for brass bar casting, compared to its continuous-casting process of today.

Compare brass bar casting methods of 1802 and 1952 at Scovill's exhibit in the National Metal Exposition

To commemorate 150 uninterrupted years of craftsmanship in metals, the Brass Mill Products Division of Scovill Manufacturing Company is presenting, in action, its early hand methods for melting and casting the first brass bars made in America, contrasted to its present-day continuous-casting process.

Here, you will see a huge coil of Scovill brass, constantly winding and unwinding before your eyes. You can inspect both sides of this ever-moving strip and see what is meant by inherent *soundness* and *uniformity*. You will see why the last pound of your order for Scovill continuous-cast brass is essentially the same as the first pound.

At Scovill's exhibit you will learn why "*You can't buy better brass!*"

Visit Scovill's Booth No. 1685, National Metal Exposition, Commercial Museum, Philadelphia, October 20-24.

"You Can't Buy Better Brass"

Brass Mill Products in a Comprehensive Range of Commercial Alloys, Shapes, Tempers and Sizes

CONTINUOUS-CAST SPECIALTIES

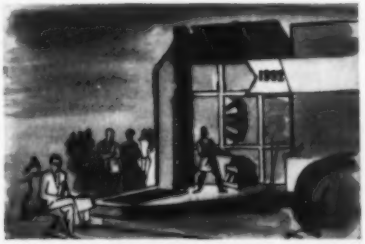
Brass Strip and Sheet *(Copper-Zinc Series)*

High Speed Brass Rod *(Free-Cutting)*

Extruded Cold-Heading Wire *(Cartridge Brass, 70%)*

Phosphorized Admiralty Condenser Tube

Standard Forging Brass *(Alloy No. 284)*



1802—Early Scovill craftsmen employed these hand methods for melting and casting first brass bars used in this country for subsequent cold-rolling into strip form. Output of these tiny brass bars, weighing 1 lb each, was only about 5 to 10 lbs. hourly.

1952—Today Scovill's unique continuous-casting process is capable of producing up to 30,000 lbs. per hour of rectangular-shaped brass bars. The Scovill flat-metal continuous-casting machine, only one of its kind in the brass industry, will be represented at the Exposition by a half size model—operating in natural color in motion. Since 1949, Scovill has offered commercially 2,000 lb. non-welded 24 in. wide brass coils; 3,000 lb. coils will be available in the near future.

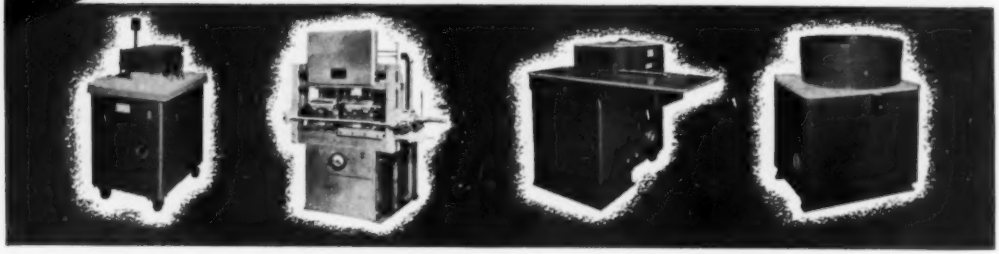
SCOVILL MANUFACTURING COMPANY, 89 MILL STREET, WATERBURY 20, CONNECTICUT

A COMPLETE LINE OF INDUCTION HEATING EQUIPMENT TO MEET EVERY PRODUCTION NEED

ECCO

SPARK GAP CONVERTERS
TUBE DRIVEN OSCILLATORS
HIGH FREQUENCY MOTOR GENERATORS
LOW FREQUENCY 60-CYCLE INDUCTION HEATERS

CALL ON ECCO!—for controlled heating applications by induction or conduction

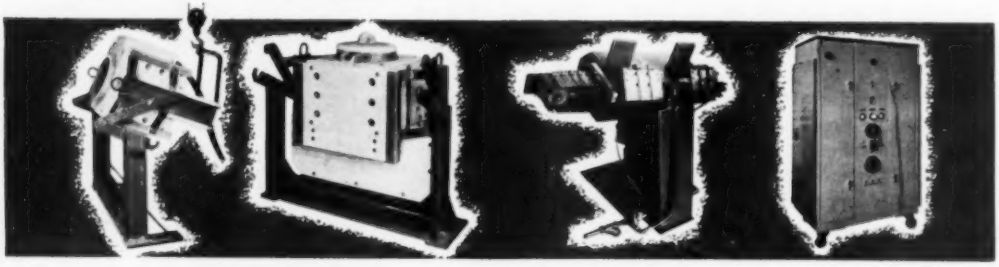


• ECCO Model M40 60-Cycle Induction-type Ring Gear Expansion Heater with automatic heat control and pneumatic release. Units available ranging from 20 to 100 KW.

• ECCO Model M47 Valve Stem Heating and Forging Machine. Completely automatic with push button control. Heats and die forms stems from round bar stock. Handles all sizes.

• ECCO Spark Converter and Conveyor-type Induction Soldering Machine. Units available ranging in capacities from 1¼" to 35 KVA.

• ECCO High Frequency Centrifugal Casting Machine with retractable induction heater coil and variable speed motor drive for precision castings.

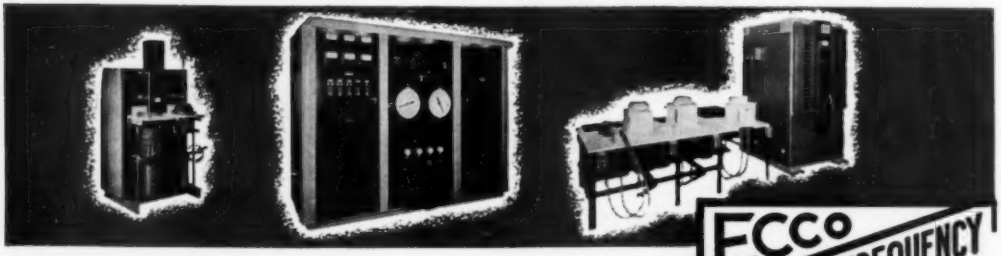


• ECCO Model F78 550-pound Tilting-type High Frequency Induction Melting Furnace.

ECCO can supply high frequency induction melting furnaces ranging from a few ozs. to several tons.

• ECCO Model M14 Conveyor-type Induction Hardening, Quenching and Drawing Machine. Capacity 2500 parts per hour.

• ECCO Model 06-50 KW Water-cooled, Tube-driven Oscillator. Output frequency range, 500 KC to 30 MC.



• ECCO High Frequency 2-Position Brazing Stand with pneumatic positioning fixture, automatic timing and temperature controls.

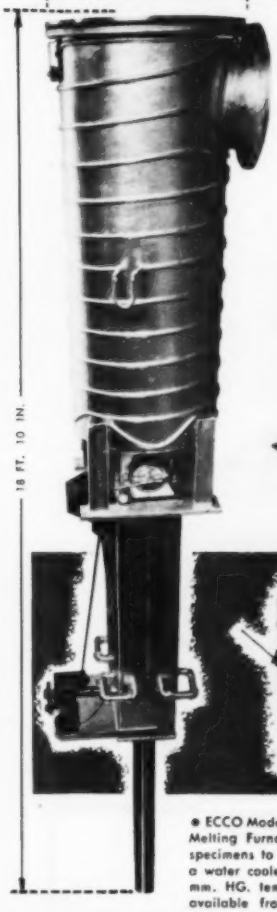
• ECCO High Frequency Motor Generator and Controls. Installations available from 20 to 1200 KW at operating frequencies from 960 to 10,000 cycles with melting capacity from 5 pounds to several tons.

• ECCO 35-KVA Spark Converter with high frequency power distribution for 4 induction melting furnaces.

ECCO HIGH FREQUENCY CORP.
7020 HUDSON BOULEVARD
NORTH BERGEN, N. J.

DESIGNERS AND

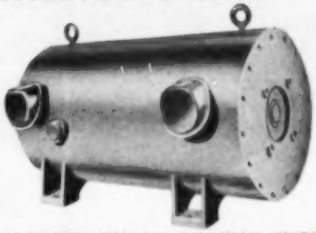
ECCO HIGH FREQUENCY VACUUM MELTING EQUIPMENT



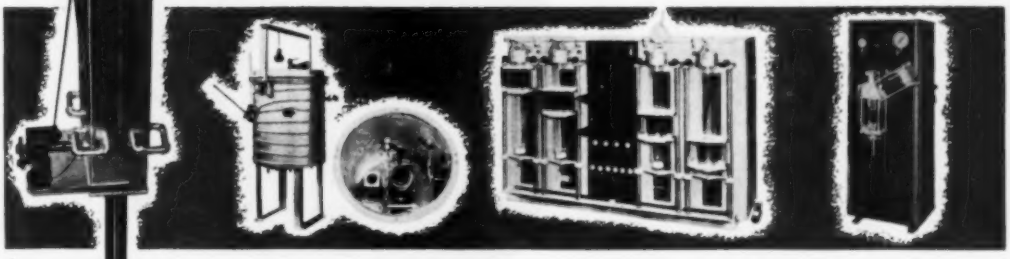
ONE OF THE LARGEST VACUUM FURNACES EVER BUILT

● ECCO Model VFR 11 Vacuum Heat Treating Furnace measures 18 ft. 10 in. in height with top diameter of 34.5 inches. Model VFR 11 includes mechanism to lower the charge into a cooling zone while still in vacuum. Operating pressure is 10^{-5} mm. HG.

● 100 KW TOTALLY ENCLOSED WATER COOLED MOTOR GENERATOR



ACCESSORIES FOR ALL INDUCTION HEATING AND MELTING OPERATIONS— ECCO can supply motor generator sets, induction heating coils, inductor blocks, quench heads, capacitors and other specialties for every induction heating and melting application. ECCO engineers will make recommendations on specific needs



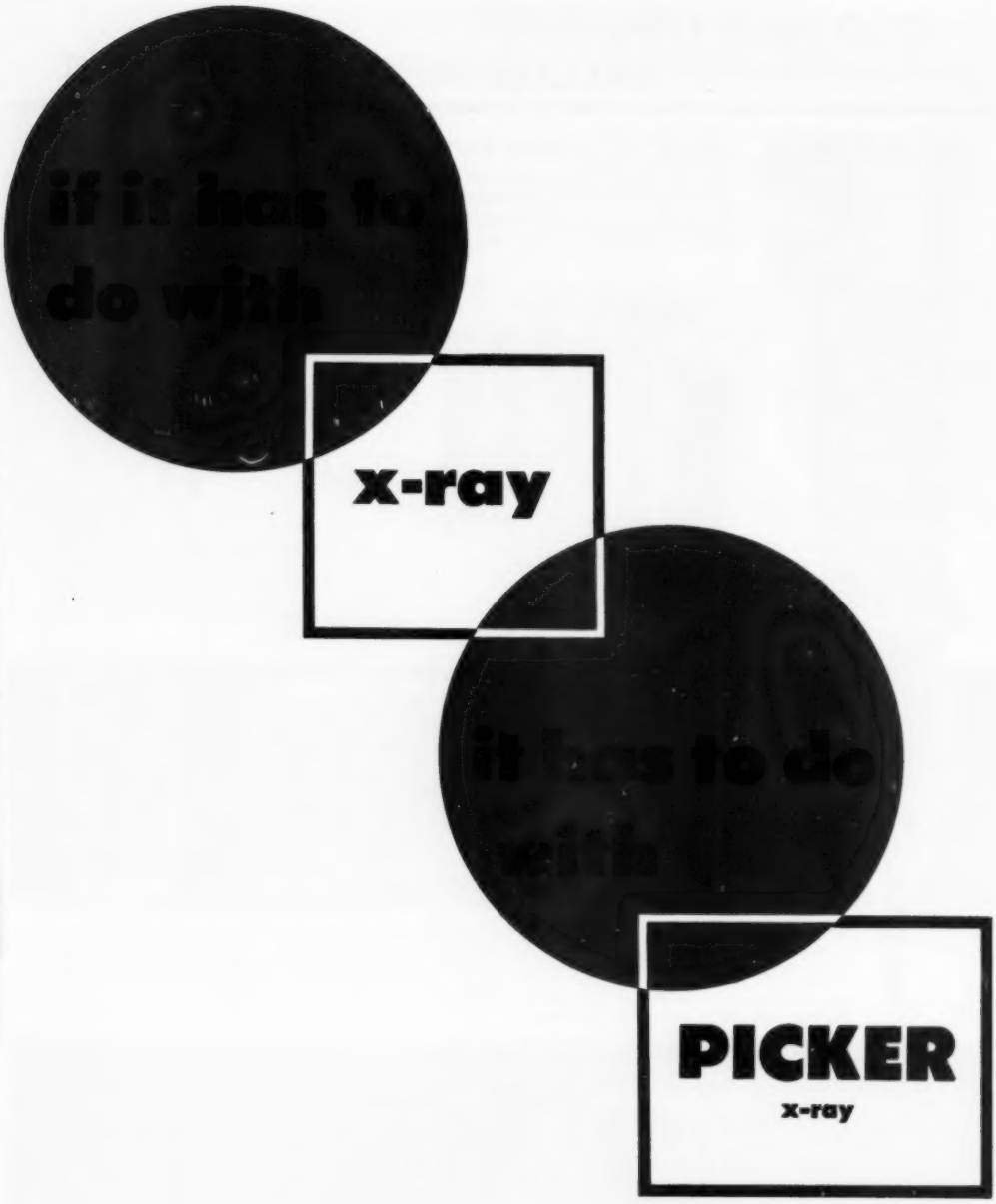
● ECCO Model F66B Coil Tilting Type High Vacuum Melting Furnace with provisions to add alloying specimens to the charge and pour the metal into a water cooled mold. Operating pressure 10 $^{-4}$ mm. HG. temperature 2000° C+. Unit capacity available from 30 to several hundred pounds.

● ECCO Model F64 Four-Position High Vacuum Degassing Furnace, complete with sliding induction heater coils, pumps and vacuum gauges.

● ECCO Model F65, 2 to 10 pound Vacuum Melt, Pour and Pressure Furnace. Furnace has provision for preheating the mold.

IF YOU HAVE A PROBLEM

MANUFACTURERS OF INDUSTRIAL HIGH FREQUENCY HEATING EQUIPMENT



Picker *specializes* in x- ay, and x-ray only, covering the field like a blanket. *Whatever you need, we've got* . . . from a simple lead letter to a 22,000,000 volt betatron. To serve you, there are sales offices and service depots in all principal cities, staffed by skilled engineers prepared to cope with any x-ray problem promptly and with understanding. If you are now using x-ray, or are wondering whether you should, you can depend on Picker for objective technical counsel and efficient handling.

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WATCH THIS ANGLE

stop losses

(THE EQUIVALENT OF)

3376 blanks this size

A sheet of exactly .022" strip steel the size of this page (8¼" x 11¼") weighs approximately 9½ ounces. The same size sheet of .024" (.022", .002" oversize) with the triangle punched out would weigh the same.

in every ton if the .022" strip steel you order actually measures .002" oversize

footage loss increases as thickness increases; decreases as gauge decreases.

the precision gauge tolerance of CMP THINSTEEL protects you against such costly losses, insures maximum practical yield per ton

CMP — the Cold Metal Products co.

these are the ANGLES you'll like

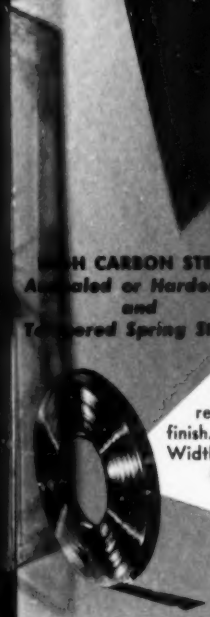
CMP

THINSTEEL

TRADE MARK

LOW CARBON STEEL

Low Carbon Steel—.25% carbon or under. Full-hard, half-hard, quarter-hard or skin-pass temper or dead soft annealed; No. 2 regular bright and No. 3 mirror finish for plating. Thicknesses: .001" and heavier. Widths: 3/16" and wider to 24".

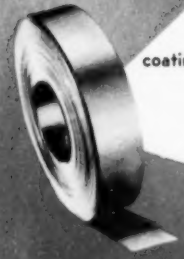


HIGH CARBON STEEL
Annealed or Hardened and Tempered Spring Steel

High Carbon over .25% to 1.35% carbon. Hard rolled or intermediate tempers to specifications—or dead-soft annealed. No. 2 regular bright and No. 3 mirror finish. Thicknesses: .001" to .093". Widths: 3/16" and wider to 24". Hardened and tempered—Bright, straw or blue colored, scaleless or polished finish. Various carbon and alloy analyses.

STAINLESS STEEL

Stainless —all popular types in standard tempers and finishes plus Bright-Annealed Chrome Nickel types (300 Series) dead soft for easy fabrication, a glistening mirror finish that requires little or no polishing. High tensile grades a specialty. Thicknesses: .001" and heavier. Widths: 3/16" and wider.



ELECTRO ZINC COATED

Electro-Zinc Coated with a tough, ductile, tight adhering zinc coating that withstands the toughest fabricating operations and gives highest corrosion resistance.

CMP THINSTEEL products can be ordered direct from the mill, or for less than mill quantities or for emergency service needs, from following warehouses:

The Kenilworth Steel Company, 750 Boulevard, Kenilworth, New Jersey, 'phone N. Y. COrtland 7-2427 or N. J. UNion Hills 2-6900.

Precision Steel Warehouse, Inc., 4400-4428 West Kinzie Street, Chicago 24, Illinois, 'phone COlumbus 1-2700.

The Cold Metal Products Company of California, 6600 McKinley Avenue, Los Angeles, California, 'phone PLeasant 3-1291.

the Cold Metal Products co.

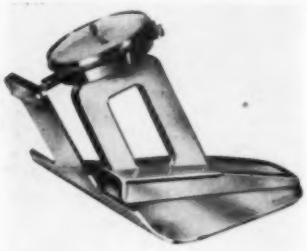
YOUNGSTOWN 1, OHIO

New York • Chicago • Indianapolis • Detroit • St. Louis • Los Angeles • Cleveland

Products at the METAL SHOW

Philadelphia, October 20-24

SHEET TESTER: Steel City Testing Machines, Inc., now offers the model B-1 Flex Tester for nondestructive testing of sheet metal for comparative drawability and stretcher-strain



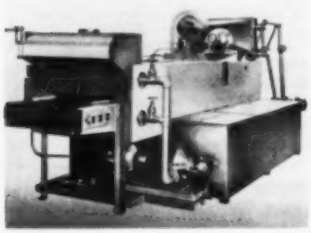
characteristics. The instrument can be used on sheet up to 0.050 in. thick. The Spherometer, which completes the test set, determines stretcher-strain characteristics from the curvature of the set left after the flex test.

For further information circle No. 916 on literature request card on p. 32B

EASY-WORKING STAINLESS: A new chromium-nickel austenitic stainless steel that work hardens far more slowly than conventional 18-8 grades has been announced by the Carpenter Steel Co. This steel makes possible commercial production of chromium-nickel steel fastenings and other parts requiring drastic cold heading or upsetting.

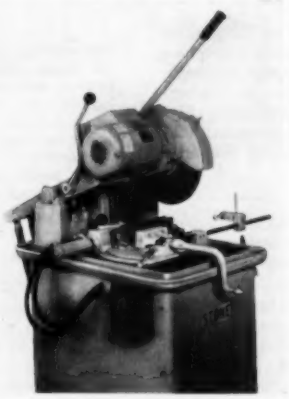
For further information circle No. 917 on literature request card on p. 32B

WASHING MACHINE: A special washing machine by The Alvey-Ferguson Co. removes grease and chips from rocker arm shafts after machining. The conveyer unit is



equipped with steel disks on which the shafts ride, thus providing minimum points of contact and maximum exposure of surface to washing and drying action.

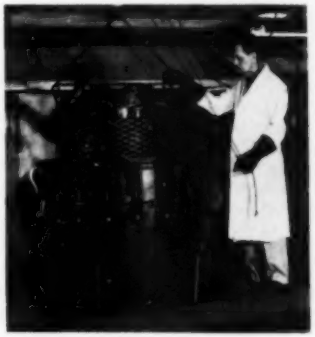
For further information circle No. 918 on literature request card on p. 32B



CUT-OFF MACHINE: The new M-75 high-speed cutting machine, a product of the Stone Machinery Co., is designed to handle heavy continuous production.

For further information circle No. 919 on literature request card on p. 32B

IMPREGNATION OF CASTINGS: Polyplastex International, Inc., has announced a new improvement in impregnation of porous castings. The manufacturer reports that Polyplastex MC resin, which contains no volatile matter, provides a sealant which does not shrink during setting and is resistant to a wide variety of solvents and withstands temperatures up to 350° F.

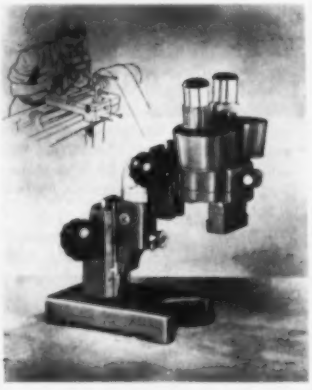


For further information circle No. 920 on literature request card on p. 32B

EXCITATION UNIT: The Varisource, by Jarrell-Ash Co., is designed to meet all the requirements for excitation in the modern spectrochemical laboratory. It is an all-in-one excitation unit providing d-c. arc, high-voltage a-c. arc and high-voltage a-c. spark circuits. The spark portion provides for easy adjustment over a wide range of inductance, capacitance, secondary resistance, primary resistance, and primary voltage.

For further information circle No. 921 on literature request card on p. 32B

STEREOMICROSCOPE: Bausch & Lomb Optical Co. has announced a new industrial stereomicroscope for production, inspection and quality control use. The instrument can be



conveniently built into production and inspection set-ups. In connection with the instrument a free consulting service is offered.

For further information circle No. 922 on literature request card on p. 32B

VACUUM PUMPS: The KS-100 ejector-diffusion booster pump is a new addition to the Distillation Prod-

AMERICAN CHEMICAL PAINT COMPANY

AMBLER CHEMICALS ACP PROCESSES PENNA.

Technical Service Data Sheet

Subject: IMPROVED DRAWING AND COLD FORMING WITH GRANODRAW

INTRODUCTION:

When steel is phosphate coated with "Granodraw" prior to working it, drawing, extrusion, and other cold forming operations are greatly improved. In fact, the protective phosphate coating makes the cold extrusion of steel possible.

Getting cold steel to flow depends on the unique properties of this coating. Its non-metallic phosphate crystals are physically and chemically adapted to acquire a strongly adsorbed lubricant. The combination of adherent phosphate coating and adsorbed lubricating film possesses a low coefficient of friction while maintaining its integrity under extremely high deforming pressures.

"GRANODRAW" DATA

"Granodraw" zinc phosphate coating chemical is applied to pickled surfaces in an immersion or spray process. When used with a suitable lubricant, the coating reduces friction under conditions of low, medium, or high deforming forces encountered in such typical operations as: cold extrusion of steel; cold shaping; deep drawing (tubs, cartridge cases, shells, etc.); stamping; drawing of wire and tubing; ironing; necking; nosing; and upsetting.

TYPICAL APPLICATIONS

WIRE. "Granodraw"-coated fine wire to be wet drawn, is given an 85% to 95% reduction in cross-sectional area at 15% to 25% greater drawing speed. In addition, the appearance and profile of the drawn wire show considerable improvement over uncoated wire drawn with conventional lubricants. One interesting advantage in the use of the phosphate coating is the corrosion resistance imparted to the drawn wire by residual coating adhering to the steel after as many as 13 holes. Loss of such wire because of corrosion during storage has been practically eliminated.

TUBING. A tube mill is accomplishing a 40% reduction and a mirror-like inside surface with the aid of "Granodraw" coatings. The speed of this draw is over 100 feet per minute and the die life is considerably longer than when no phosphate coating is used.

PLATED WORK. Articles to be plated after forming may now be polished in the flat, formed on the presses, and sent to the plating line with no further polishing. The application of a "Granodraw" phosphate coating and lubricant protects the polished surface during press operations, preventing scratches and gall marks from appearing. Since contour polishing and hand buffing are very expensive, their elimination by the use of "Granodraw" provides considerable savings.

The drawing of wire and many other cold forming operations — including the cold extrusion of steel — are greatly facilitated by the application of a "Granodraw" phosphate coating and a suitable lubricant prior to working.

TYPICAL APPLICATIONS (Cont'd)

CARTRIDGE CASES. The phosphated, lubricated cup for a large cartridge case is given an 80% reduction in four passes with no intermediate anneals or surface treatments. Finish is excellent and the total life extended considerably over components formed without the use of the phosphate coating. In another case, a cup for a shell is phosphated and lubricated and given a 67% reduction with one pass through two dies.

ADVANTAGES OF PHOSPHATE COATING WITH "GRANODRAW" PRIOR TO COLD FORMING STEEL

The following are among the advantages indicated for phosphate coating with "Granodraw" prior to cold forming steel:

Drawing of wire, bars, tubing, etc.—Improved lubrication; improved surface; less scratching; reduced pull; greater percent reduction per pass; reduced die wear; longer die life; lower die maintenance and cost; reduction in corrosion.

Drawing of stampings, shells, shell cases, etc.— Improved lubrication; reduced breakage; reduction in scrap; deeper draws; less scratching; elimination of some annealing; less wear on dies.

Cold Extrusion — Improved lubrication; increased strength of parts; improved surface; reduction in load on press; greater dimensional accuracy; more uniform wall thickness; longer extrusions; elimination of some annealing; less corrosion.

CHEMICALS ACP PROCESSES

WRITE FOR FURTHER INFORMATION ON "GRANODRAW" AND ON YOUR OWN METAL PROTECTION PROBLEMS.

CHEMICALS ACP PROCESSES

ucts Industries' line of vacuum equipment. The pump, only 24 in. high, with a pumping speed of 140 liters per sec. and a limiting forepressure of just less than 1 mm. Hg, is a large capacity pump for installations where small space is available.

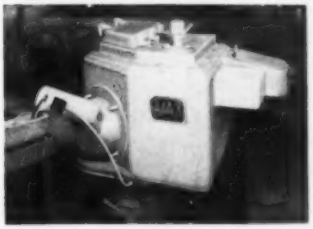
For further information circle No. 923 on literature request card on p. 32B

HEAT TREATING FURNACE: A new medium size heat treating unit of 500-lb. per hr. capacity has been announced by Ipsen Industries, Inc. The new model is available for either electric or gas operation. Automatic

sealed atmosphere and temperature control and automatic transfer of work from heat through the quenching or cooling cycle (without breaking the atmosphere seal) are provided.

For further information circle No. 924 on literature request card on p. 32B

POURING UNIT: The Ajaxomatic, a new automatic unit for pouring accurate amounts of metal into molds, is designed to discharge molten metal, in particular aluminum, directly into the cold chamber of most available die casting machines. Molten metal is taken from a point considerably below



the surface of the melt, eliminating any chance for pouring surface oxides or scum into the casting. The Ajaxomatic acts as a combined holding furnace and automatic pouring unit. Made by Ajax Engineering Corp., this unit is not a melting furnace. It was designed especially to fit the requirements of aluminum die casting plants and can also be used for zinc alloys, pointing the way to the economic use of cold chamber machines for that purpose, if desired. *(Continued on p. 274)*

Pete says the only thing that will shear his wife's biscuits is Columbia Buster Alloy Tool Steel.

COLUMBIA TOOL STEEL COMPANY • CHICAGO HEIGHTS, ILL.

Producers of fine tool steels—High Speed Steels Die Steels—Hot Work and Shock Resisting Steels Carbon Tool Steels.

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Nearly 100 SIZES

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PRESSED STEEL POTS For Lead, Salt, Cyanide, Oil Tempering, Metal Melting.

Pressed Steel means Dependability.

Eclipse Pressed Steel Pots are seamless formed from ¼" firebox plate. They are uniform in quality, relatively light in weight. Thirty-odd years of service has proved them ideal for all heat-treating operations and for the melting of lead base alloys. They offer dependable long life, freedom from sudden failure, higher strength at elevated temperatures, marked savings in fuel costs, increased production and immediate availability.

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FROM BANJO STRINGS

TO AIRPLANE WINGS

you can test practically anything with a

RIEHLE
UNIVERSAL
TESTING MACHINE

Every Riehle Pendomatic Universal Testing Machine has 5 standard scale ranges, so that it is actually the equivalent of 5 testing machines in one. You can test small specimens with a relatively low-rupture-point (banjo strings, for example) or large high-yield-point specimens (like airplane wings) all on the same Riehle machine. No accessories are needed; all you do is turn the selector knob to the desired range. Guaranteed accuracy is within ½ of 1%.

Hydraulic and Screw Power Types

Riehle Universal Testing Machines are built both with hydraulic loading unit and with screw power loading unit. Each type is available in a variety of sizes, with capacities up through 400,000 lbs. Ask your Riehle representative or write our factory for illustrated catalogs.

What's new

IN MANUFACTURERS' LITERATURE

978. Abrasion Tester
Bulletins on durable precision instrument for testing resistance of surfaces to abrasion. *Taber Instrument*

979. Abrasive Wheels
Data folders give operating suggestions and recommended grades of abrasive wheels for stainless alloys, for finishing, semi-polishing and other applications. *Manhattan Rubber Div.*

980. Air-Gas Mixer
Engineering and application data on air-gas proportional mixer in Bulletin L-300. *Eclipse Fuel Engineering*

981. Alkaline Derusting
Bulletin on electrolytic process operated at room temperature, for derusting without acid. *Enthone*

982. Alloy Steel
68-page "Aircraft Steels" booklet includes revised military specifications. Also stock list. *Ryerson*

983. Alloy Steel
40-page book on heat treated alloy steel plate for maximum abrasion and impact resistance. Details on uses; 12 pp. of technical data. *Jones & Laughlin*

984. Alloy Steel
176-page bound book on hardenability, mechanical properties, heat treatment and applications of alloy steels. 28 pages of tables at end. *U. S. Steel*

985. Aluminum Castings
Brochure "How To Cut Die-Casting Finishing Costs" deals with aluminum castings. *Monarch Aluminum*

986. Aluminum Extrusion
Bulletin 340-A on aluminum extrusion process and presses of 500 to 5000 tons capacity. *Watson-Stillman*

987. Aluminum Fasteners
8-page illustrated booklet on all types of aluminum fasteners. Also accessories and screw machine products. *Alcoa*

988. Aluminum Forgings
168-page book covering relation of forging design to die sinking and to the manufacturing process. Section on metallurgy gives commercial alloy compositions, properties and tolerances. *Alcoa*

989. Aluminum Melting
Folder A-5 describes automatic melting and pouring unit for production of aluminum die castings. *Ajax Eng'g.*

990. Aluminum Welding
New control system that extends electrode life for spot welding aluminum, fully described in "Technical Advisor 15". *Reynolds Metals*

991. Ammonia for Heat Treat
20-page booklet, "Ammonia Installations for Metal Treating", gives properties of ammonia used in heat treating and describes equipment. *Armour*

992. Analysis
Article on use of direct-reading spectrometer at Kaiser Steel. *Baird Assoc.*

993. Analytical Balance
Pamphlet on analytical balance having automatic indication of end result by projection of enlarged image of true micrometer scale. *Sartorius Div.*

994. Annealing Furnaces
8-page illustrated booklet on continuous annealing furnaces. Schematic diagrams, photographs, and actual production data. *Drever*

995. Anodizing Racks
Folder gives data on aluminum racks with copper hooks, insulated for any anodizing solution. *National Rack*

996. Arc Welders
Illustrated booklets available on both A-C and D-C arc welders. Contain data and diagrams on construction and uses. *Westinghouse Electric*

1000. Automotive Forgings
Folder shows 31 forged parts made for automotive industry. *Pittsburgh Forgings*

1001. Barrel Finishing
55-page book on barrel finishing with Alundum tumbling abrasive. Procedures, practical operating suggestions, and characteristics of abrasive. *Norton Co.*

1002. Bearing Failures
12-page bulletin 146 outlines basic steps for prevention of common babbitted bearing failures—choice of metal, pouring practice, in-service maintenance. *Federated Metals Div.*

1003. Beryllium Copper
Helpful engineering information contained in monthly beryllium copper technical bulletins. *Beryllium Corp.*

1004. Bimetal Elements
64-page book on application of thermostatic bimetal. Property charts for 30 types. Design formulas. *W. M. Chace*

1177. Magnesium Finishing

Surface finishing of the lightest structural metal gets A to Z treatment in "Magnesium Finishing".★ In 128 pages of text, accompanied by illustrations and tables, this new publication outlines the details of cleaning, mechanical finishing, chemical treatment, electroplating, painting and assembly protection for all forms of magnesium.

Emphasis throughout the book is on specific details of the various finishing operations. Protection afforded, bath compositions and temperatures, equipment, materials and treatment times are discussed for each treatment. The detail is balanced in the opening sections of the book by a general discussion of the proper choice of finishing system and of the general types of corrosive conditions against which magnesium must be protected.

Of special interest is the section on electroplating, the most recent development in magnesium finishing. Procedures have now been worked out which permit the plating of magnesium with any metal which can be electrodeposited. The text also reports recent improvements in primer coat formulations and adjustments in treating bath compositions to provide better protection.

Final effectiveness of coating processes depends on initial cleaning. Assistance in choosing the proper cleaning method is provided.

Ten chemical treatments — paint base, black, anodic and bright finishing types — are presented in detail. The characteristic finish resulting from each treatment is discussed and proper procedure is outlined. Each procedure is diagrammed in a flow chart on which variables are noted. Control of the procedures is covered in gratifying detail. Analytical determination methods are given and difficulties are discussed on a symptom-and-remedy basis.

★Published by The Dow Chemical Co. Copies are available at no charge to readers of Metal Progress who circle No. 1177 on the literature request card, page 32B.

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997. Atmosphere Furnaces
Information on gas-atmosphere high-production furnace for bright annealing of copper alloys. *Holcroft*

998. Atmosphere Generators
12-page booklet on gas producers describes equipment and gives data on composition and applications of atmospheres. *Bellevue Industrial Furnace*

999. Automotive Case Hardening
Reprint on case hardening automobile parts. Operating data and cost analysis. *Dow Furnace*

1005. Black Coating
Technical bulletin on Parco Black finish, having high corrosion resistance on steel. *Parker Rust Proof*

1006. Blackening Compounds
Bulletin on blackening compounds (for ferrous alloys) to AMS Spec. 2485. *Swift Industrial Chemical*

1007. Brass and Bronze
8-page booklet on control methods applied to brass rod, forgings, die castings and welding rod. *Titan Metal*

1008. Brazing
50-page text GEA-3193 describes the methods and applications of electric-furnace brazing. *General Electric*

1009. Brazing
24-page bulletin 20 on advantages of Easy-Flo silver brazing alloy, with information about joint design and fast production methods. *Handy & Harman*

1010. Brazing Stainless Steel
Illustrated booklet, "Bright Annealing, Hardening and Brazing Stainless Steel", describes conveyor furnace and bright brazing alloy. *Sargeant & Wilbur*

1011. Brazing Titanium
Data sheet on use of a new flux for brazing titanium. *Handy & Harman*

1012. Brazing Washers
Free sample of silver brazing alloy preformed washer coined from wire. *Lucas-Milhaupt Engineering Co.*

1013. Bright Carburizing
Case history on bright carburizing of SAE 8620 bull gear pinions. *Ipsen*

1014. Bronze
12-page technical bulletin on seven grades of bearing bronze. Six case histories. *American Crucible Products*

1015. Bronze, Continuous Cast
12-page bulletin on applications, properties, weights of continuous cast bronze rods, tubes, shapes. *American Smelting & Refining*

1016. Bronze Castings
16-page booklet on sand and centrifugal castings. *Amer. Non-Gran Bronze*

1017. Bronze Electrode
Data sheet on phosphor bronze arc welding electrode for high-strength welds on phosphor and manganese bronzes. *Weldwire*

16 Foot Lathe Bed Wear Strips
Quick Aged in SUB-ZERO Unit

18 foot Sub-Zero —120° F. Chilling Machine in which parts are quick aged. Unit has two covers on single opening for easier handling.

This Sub-Zero Industrial Chilling Machine plays a vital part in a unique steel treating line for lathe bed wear strips recently installed at the Cincinnati Steel Treating Co.

After flame hardening, temperature of the strips is about 80° F. They are then put into the Sub-Zero unit, and held for a period of 24 hours at —120° F. The result of this chilling is a complete transformation of the austenite to martensite, producing full stabilization. A second result is a major improvement in surface hardness. The parts are ready for finish machining and grinding to final dimensions after a draw to thoroughly temper the martensite.

Several Sub-Zero models for large or small shops save time and money by: Shrink fitting without forcing, increasing perishable tool life, and obtaining 100% stabilization of alloy steel.

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BOOTH 1320

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SOME EXCLUSIVE TERRITORIES NOW OPEN TO DEALERS

1018. Buffing and Cleaning
24-page booklet describes origin and development of various metal cleaners and tripoli compositions. *Puritan Mfg.*

1019. Buffing and Polishing
Catalog A-50 on five-head rotary machine for automatic polishing and buffing of parts from 1/16 to 12 in. diameter. *Hammond Machinery*

1020. Burners
Bulletin 1220-5 describes tempered flame burners for controlled heating and cooling cycles. *Bloom Engineering*

1021. Car Bottom Furnaces
Bulletin 644 on electric car bottom furnaces for all heat treating processes. *Hevi Duty Electric*

1022. Carbon Steel Tubing
Bulletin TB 333 gives cost-saving details on mechanical tubing. *Babcock & Wilcox*

1023. Carbon Test
Illustrated data discusses melter's test for estimating carbon content of molten steel in 40 sec. *Harry W. Dietert*

1024. Carbonitriding
Case history and job data on bright carbonitriding of SAE 1010 levers. *Ipsen*

1025. Carburizer-Nitrider
28-page Bulletin 646 on electric carburizing and nitriding furnace giving atmosphere circulation up to 1850° F. *Hevi Duty Electric*

1026. Carburizing Baths
Bulletin contains charts of relative case penetrations at various times and temperatures. Also replenishment chart for salt baths. *A. F. Holden Co.*

1027. Carburizing Salts
Folder on salts for liquid carburizing. *Swift Industrial Chemical*

1028. Castings, Bimetallic
16-page brochure illustrates 50 applications of casting process for making bi-metallic components. *Al-Fin Div.*

1029. Cemented Carbides
64-page catalog 52 gives latest information on carbide tooling. Completely illustrated details on all types of cutting tools. Handy tables for grade selection and cutting speeds. *Kennametal*

1030. Ceramic Coating
24-page book on ceramic coating as a means of conserving strategic metals and extending metal life at high temperatures. *Solar Aircraft*

1031. Clean Hardening
Bulletin describes clean hardening of steering arms and lever shafts at Ross Gear & Tool. *Surface Combustion*

1032. Cleaner
Data sheet on "404", alkaline soak cleaner for steel and brass. *Diversey*

1033. Cleaner
Folder gives data on industrial metal cleaners for use with water in either still-tank or spray-washing equipment. *Solventol Chemical Products*

1034. Cleaner
Technical specifications for surface active agent used with both acid and alkaline cleaners. *Alrose Chemical Co.*

1035. Cleaners
40-page catalog of cleaning and finishing chemicals, solutions, and reagents. *Globe Chemical*

1036. Cleaning
Bulletin on equipment for cleaning and pickling of shell cases and other ordnance items. *Alvey-Ferguson*

1037. Cleaning
12-page Bulletin 68 deals with factors to consider in selecting metal cleaning equipment. *Despatch Oven*

1038. Cleaning
20-page bulletin 214 gives full details, specifications and actual performance on Rotoblast cleaning. *Pangborn*

1039. Cleaning
Pamphlet on properties and use of trichlorethylene. *Niagara Alkali*

1040. Cleaning Aluminum
Technical data sheets on aluminum cleaners to remove drawing, stamping, spinning compounds, rolling oils, marking inks and crayons as well as general shop dirt. *Cowles Chemical*

1041. Cleaning and Finishing
16-page brochure on various cleaning processes, phosphating, aluminum brighteners and rust preventives. Reference chart included on six phosphating cycles. *Turco Products*

1042. Cleaning and Finishing
Catalog A-653 gives complete story on planning industrial finishing systems and shows many installations of cleaning and pickling machines. *R. C. Mahon*

1043. Cleaning Equipment
Vapor degreaser described and diagramed in folder. Data on different models. *Topper Equipment*

1044. Cleaning Machines
Bulletin 703 on cleaning machine that agitates and lifts work. *Magnus*

1045. Coating Gage
Folder on portable instrument to measure thickness of nonmagnetic coatings on magnetic bases. *Branson*

1046. Coatings
Information on Bonderite coating which is resistant to corrosion and a good paint base. *Parker Rust Proof*

1047. Coatings and Packaging
43-page guide to better preservation and packaging deals with procedures for hot dip packaging. *Seal-Peel*

1048. Cold Extrusion
Bulletin describes process in which 5-in. dia. steel billet can be cold formed to a cup with less than ⅛ in. wall thickness in three strikes. *Detrex Corp.*

1049. Cold Finished Bars
Engineering bulletin, "New Economies in the Use of Steel Bars". *LaSalle Steel*

1050. Cold Heading Brass Wire
"Cold Heading Extruded Brass and Copper Wire" gives physical and fabrication properties, applications, lb. per 1000 ft. and ft. per lb. *Chase Brass*

1051. Combustion Equipment
8-page folder on catalytic fume combustion. *Catalytic Combustion*

1052. Continuous Casting
24-page book, "Better by the Mile", describes how the Rossi continuous casting machine works. History of continuous casting. *Scovill Mfg.*

1053. Control Instrument
Bulletin CI-1 on control device that anticipates fuel needs and minimizes on and off variation. *Wheelco*

1054. Controlled Atmospheres
24-page bulletin describes production problems with reference to dry atmospheres. *Pittsburgh Lectrodryer*

1055. Controlled Atmospheres
Bulletin on Dewpointer for reading of atmosphere in field and laboratory. Readily portable, operating on a.c. or enclosed battery. *Illinois Testing Labs.*

1056. Copper Alloy Tubes
32-page brochure on causes of corrosion and means of combating them. Choice of materials for condenser tubes. *Revere Copper & Brass*

1057. Copper Tubing
6-page illustrated folder gives useful data on seamless copper tubing. Chart featuring safe-working internal pressures for both annealed copper and hard copper seamless tubing. *Penn Brass & Copper Co.*

1058. Corrosion Protection
8-page bulletin shows 24 applications of vapor wrap method of corrosion protection. *Angier*

1059. Cutting Oil
Facts on more efficient and economical plant operation through use of right lubricants described in "Metal Cutting Fluids". *Cities Service Oil*

1060. Cutting Oil
New pamphlet on sulphurized oil applicable to stainless steel and more easily machined alloys. *Gulf Oil*

1061. Deep Drawing
Reprint on new deep drawing technique involving single-stroke dies and eliminating intermediate operations. *Schnell Tool & Die*

1359. Welding Electrodes

A new 9-in. slide rule permits comparison of the welding electrodes of 23 manufacturers. AWS designations are printed on the faces of the comparator and, as the slide

is adjusted, electrode designations of each manufacturer come into view opposite the corresponding AWS numbers. Stainless steel electrodes are given on the front face; others, on the back. Fifty-four types of electrodes are included. *General Electric*

1062. Definitions
36-page glossary of over 150 terms on cast iron. *International Nickel*

1063. Descaling Stainless Steel
Bulletin 25 on descaling stainless steel and other metals in molten salt. *Hooker Electrochemical*

1064. Design of Dies
32-page bulletin on design of dies for upset forging. Also rules for upsetting and examples of forgings. *Ajax Mfg.*

1065. Dew-Point Recorder
Bulletin 407 and Data Sheet AED 340-7 on dew-point systems for recording or controlling. *Foxboro*

1066. Dial Gages
36-page catalog of dial gages of all types. *Nilsson Gage.*

1067. Diamond Abrasives
8-page booklet on characteristics of diamond abrasive, and catalog of diamond finishing accessory line. *Elgin National Watch*

1068. Die-Casting Machines
Catalog shows complete line of die casting machines. *Kux Machine Co.*

1069. Die Castings
Bulletin on design and manufacture of aluminum die castings. *Hoover Co.*

1070. Dimensioning
40-page "Practical Dimensioning" tells how to avoid errors in the dimensioning of drawings. *Gisholt Machine*

1071. Drawing and Forming
Literature on Granodraw coating for improved drawing, cold extrusion and cold forming. *American Chemical Paint*

1072. Drawing Compounds
Folder describes new type of lubricant for cold forming and drawing of stainless steel, both austenitic and ferritic. *Hangsterfer's Laboratories*

1073. Drum Cleaning
6-page brochure on fast, low cost drum cleaning. *Pangborn*

1074. Dryer, Centrifugal
Bulletin gives specifications and drawings of centrifugal dryer for small parts. *Nobles Engineering and Mfg.*

1075. Ductile Iron
Bulletin compares ductile iron with gray iron, malleable iron and cast steel. Eight examples of applications where ductile iron is profitably employed. *American Brake Shoe*

1076. Electric Furnaces
17-page Bulletin 1054 on tool hardening equipment. *Sentry*

1077. Electric Furnaces
Brochure on electric heat treating furnaces, melting furnaces, metallurgical tube furnaces, research furnaces and sintering furnaces. *Pereny Equipment*

1078. Electric Melting
Bulletin 527 on compact arc furnace. Melt time and power consumption for four alloys. *Detroit Electric Furnace*

1079. Extrusions
Data on services in the field of aluminum extrusions. *Himmel Bros. Co.*

1080. Fabrication Data File
Reference file contains engineering information about equipment and processes used for metal stampings, heavy weldments and pressed steel shapes. *Chas. T. Brandt, Inc.*

1081. Fasteners
22-page handbook of industrial fasteners. *Southco.*

1082. Ferro-Alloys
64-page book describes over 50 metals and alloys produced by company. *Electro Metallurgical Co.*

1083. Finish for Aluminum
Bulletin on Polychrome decorative metallic finishes for aluminum. *Alcoa*

1084. Finishes
Folder gives characteristics and uses of chromate conversion coatings on nonferrous metals. *Allied Research*

1085. Finishing
20-page bulletin on mechanical finishing. Deburring, descaling, polishing, Britehoning, coloring. *Roto-Finish*

1086. Finishing
Six bulletins describing finishing compounds for stainless steel, aluminum, other metals. *Apothecaries Hall*

1087. Finishing
22-page book gives facts and figures on barrel finishing, tells how single-unit installation may yield savings up to 95% on various parts. *Almco Div.*

1088. Finishing
Folder describes equipment for barrel plating with unique contact arrangement for maximum current distribution. *Daniels Platino Barrel & Supply*

1089. Flaw Detection
Information on electronic equipment for nondestructive inspection of regular and irregular iron and steel parts. *Magnetic Analysis Corp. (Foerster)*

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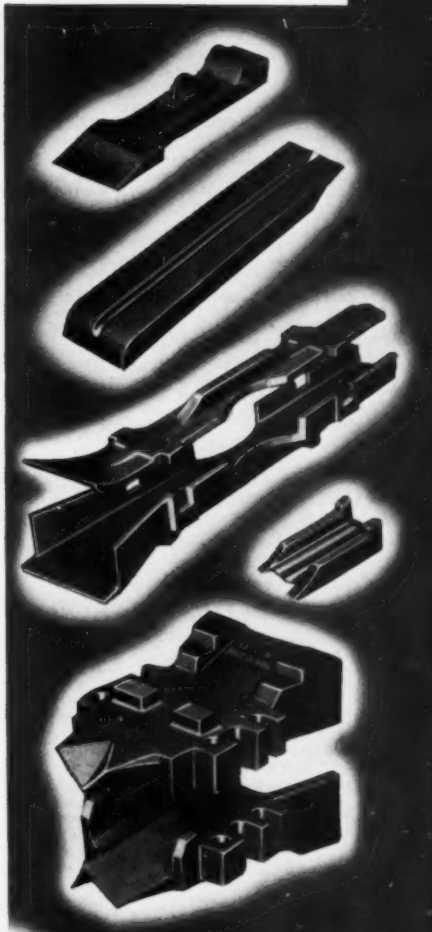

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1090. Flow Meters
Catalog C-12 describes meters and accessories for measuring pressure, vacuum and differential pressure of liquids and gases. *Meriam Instrument*

1091. Forging Hammers
24-page brochure describes construction and use of steam drop hammers. *Erie Foundry*

1092. Forging Presses
Catalog 42 gives complete specifications for high-speed forging presses in capacities from 300 to 4000 tons. *Bliss*

1093. Forgings
Catalog GI on types of upset and hammer forgings for various applications. *Commercial Shearing & Stamping*

1094. Forgings
New booklet on smooth hammered forgings of alloy, stainless and tool steel. *Allegheny Ludlum*

1095. Forming
86-page book on equipment and process of cold roll-forming. Wide sheets, narrow trim, tubular shapes, curving, coiling, tooling needed. *Yoder*

1096. Forming
32-page catalog on machinery for forming, cutting and punching operations on medium and light weight materials. *O'Neil-Irwin*

1097. Foundry Practice
Article on refining secondary copper alloys deals with sequence of removal of Al, Mn, Si, P, Fe, Zn, and use of pure oxygen instead of air. *R. Lavin & Sons*

1098. Furnace Controls
Instruments and controls for heat treating furnaces are described in bulletin 51-750-51. *Hays Corp.*

1099. Furnace Fixtures
16-page Catalog 16 on baskets, trays, fixtures, retorts and carburizing boxes for heat treating and quenching; 66 designs. *Stanwood Corp.*

1100. Furnaces
Folder on furnaces and atmosphere generating equipment for bright annealing, brazing, hardening, sintering, soldering. *Sargeant & Wilbur*

1101. Furnaces
Catalog on electric furnaces for tool room and general-purpose heat treating; also 600° F. ovens. *Cooley Electric*

1102. Furnaces
Bulletin on furnaces for annealing, normalizing, hardening, tempering, forging. *Flinn & Dreffein Engineering*

1103. Furnaces
Bulletin describes 18 electric furnaces for research and small-scale production, with operating temperatures to 3000° F. *Harper Electric Furnace*

1104. Furnaces
44-page Catalog 112, well illustrated, features furnaces for hardening, tempering, carbonitriding, forge heating, sintering, annealing and tool heat treating. Also atmosphere generators and ammonia dissociators. *C. I. Hayes*

1105. Furnaces
16-page booklet "Proven Heat Treating Efficiency" displays complete line of furnaces. *Loftus Engineering*

1106. Furnaces
Bulletin 435 describes new furnaces for tool room, experimental or small batch production. Gas, oil, electric. Muffle or direct heated. *W. S. Rockwell*

1107. Furnaces, Annealing
Folder of performance and cost data on radiant tube and roller hearth furnaces. *Gas Machinery*

1108. Furnaces, Small Tool
Folder describes complete set-up for heat treatment of small tools, including draw furnace, quench tank and high temperature furnace. *Waltz Furnace*

1109. Galvanic Coating
8-page booklet 452 on galvanic coating applied by brush. *Galvanite Corp.*

1110. Gas Analysis
Bulletins 804 and 805 on quick, accurate, direct analyses for oxygen and CO_2. *Bacharach Ind. Instrument*

1111. Gas Cutting Machine
Catalog on Airco No. 50 Travograph gas cutting machine, with manual, magnetic, or automatic tracing device to cut intricate shapes. *Air Reduction*

1112. Gas Furnaces
32-page catalog on high-speed gas furnaces for heat treating carbon and alloy steels; also pot furnaces for salt and lead hardening. *Charles A. Hones*

1113. Gas-Oil Burner
Bulletin on combination gas and oil burner with high rate of combustion. *Ra-Diant Products*

1114. Gear Cutting
8-page article on cutting fluids for gear cutting, from Notebook. *D. A. Stuart*

1115. Hardening Retainer Plates
Job data on carbonitriding of SAE 1010 clutch retainer plates. *Ipsen*

1116. Hardening Tool Steel
Notes on hardening nondeforming tool steel. *Pittsburgh Tool Steel Wire*

1117. Hardfacing
New 40-page booklet, "Haynes Alloys —Hard-Facing Manual", tells what metals can be hardfaced, how to select right hardfacing material, lists step-by-step application procedures and industrial applications. *Haynes Stellite*

1118. Hardness Tester
Bulletin F-1689-1 on Impressor hardness tester for aluminum, copper, brass, bronze, plastics. *Barber-Colman*

1119. Hardness Tester
Literature on Brinell testing machines. *Detroit Testing Machine Co.*

1120. Hardness Tester
4-page bulletin on Brinell hardness tester weighing 26 lbs. for portable and stationary use. *Andrew King*

1121. Hardness Tester
Bulletin DH-114 on Tukon hardness testers in research and industrial testing. *Wilson Mechanical Instrument*

1122. Hardness Tester
Bulletin ET 202 on new Ernst portable hardness tester for direct at-the-job readings of all metal types and shapes. *Newage International*

1123. Heat Resistant Castings
New bulletin 952 on stainless and heat resistant castings. *Fahralloy*

1124. Heat Resistant Finish
New brochure on silicone-base heat-resistant finish. *Midland Ind. Finishes*

1125. Heat-Resisting Alloy
Pyrasteel bulletin describes chromium-nickel-silicon alloy for service economy in resisting oxidation and corrosion to 2000° F. *Chicago Steel Foundry*

1126. Heat-Resisting Alloy
"Hastelloy Alloy X" booklet describes new Fe-Ni-Cr-Mo alloy, properties and forming characteristics. *Haynes Stellite*

1127. Heat Treating
Set of 20 data sheets on salt baths for case hardening, quenching, high temperature heating, tempering and brazing. *Heatbath*

1128. Heat Treating
Catalog 116 contains 72 pages of heat treating data for carburizing, cyaniding, brazing, austempering and annealing processes. *Ajax Electric*

1129. Heat Treating
12-page bulletin on heat treating in a steam atmosphere. *Leeds & Northrup*

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1130. Heat Treating
Bulletin 120 tells how heat exchangers provide heat control in quenching bath, thus protecting physical properties and saving on water and piping equipment. *Niagara Blower*

1131. Heat Treating Aluminum
Bulletin 14-T on ovens for heat treatment of aluminum and other low-temperature processing. *Young Bros.*

1132. Heat Treating Ammonia
Literature on standard anhydrous ammonia for heat treating. *Nitrogen Div., Allied Chemical & Dye Corp.*

1133. Heat Treating Baskets
Data sheet on metal baskets for heat treating, quenching, nitriding, pickling and galvanizing. *Rose Iron Works*

1134. Heat Treating Belts
44-page catalog describes metal belts for quenching, tempering, carburizing and other applications. *Ashworth Bros.*

1135. Heat Treating Fixtures
Extensive catalog on heat and corrosion-resistant equipment for heat treating and chemical processing. 30 classifications of equipment. *Pressed Steel Co.*

1136. Heat Treating Fixtures
Catalog B-8 describes and shows 75 custom-built fabricated alloy heat treating accessories. *Rolock*

1137. Heating
Full details of high thermal release burner unit intended for use where quick heating and intense concentration of heat are desired. *Bloom Engineering*

1138. Heating Elements
24-page Bulletin H on electric heating elements. Includes extensive tabular data on physical and electrical specifications for various sizes. *Globar Div.*

1139. Heating Equipment
Bulletin, "Make Your Own Gas", describes generator to convert oil to gas for standby or primary fuel. *Vapofier*

1140. Heating of Plating Baths
Illustrated bulletin on unit heat exchangers designed to maintain working temperature of nickel plating solutions by continued heating or cooling in the same unit. *Industrial Filter & Pump*

1141. Heating With Gas
12-page Bulletin S-7.1 on basic engineering requirements of heat processing with radiant gas. *Selas*

1142. Heliarc Welding
Pocket-sized folder contains current ranges and sizes for electrodes with table on current and number of passes required to weld various metals. *Linde*

1143. High-Alloy Castings
Bulletin FC-350 outlines advantages of improved Fahrite corrosion-resistant castings. *Ohio Steel Foundry Co.*

1144. High-Alloy Castings
New 28-page 3rd edition of "Nickel-Chrome Castings to Resist Heat & Corrosion". *Standard Alloy*

1145. High-Temperature Alloy
Property data for 21% Cr, 9% Ni heat-resistant alloy. *Electro-Alloys Div.*

1146. High-Temperature Alloys
High temperature work sheet provides valuable suggestions for solving high temperature problems in design and production. *International Nickel*

1147. Hollow Die Steel
New catalog section on hollow die steels. *A. Milne*

1148. Identifying Stainless
Cardboard chart outlining systematic method for rapid identification of unknown or mixed stocks of stainless steels. *Carpenter Steel*

1149. Immersion Melting
12-page Bulletin IE-11 on immersion heating for controlled melting of soft metals. *C. M. Kemp Mfg.*

1150. Impregnation of Castings
Literature on new impregnating equipment for elimination of porosity in ferrous and nonferrous castings. *Metallizing Co. of America*

1151. Impregnation of Castings
Bulletin on sealants and methods to correct microporosity in ferrous and nonferrous castings. *Polyplastex*

1152. Induction Heating
"Induction Heating and Melting" contains selector chart and table of heating and melting speeds for standard induction equipment. *Ajax Electrothermic*

1153. Induction Heating
Bulletin on low-frequency (60 cycle) induction heating furnace. Applications. *Magnethermic*

1154. Induction Heating
Data folder on megacycle tube-type machines for soldering, brazing, annealing and hardening. *Sherman Industrial Electronics Co.*

1155. Induction Heating
Specifications for 10-kw. high-frequency Model T-10-3. *Lepel*

1156. Induction Heating
Bulletin 1440 on system for safety control of induction heating through use of components built into every unit. *Lindberg Engineering*

1157. Induction Heating
New 60-page catalog, "Tocco Induction Heating", tells of reduced cost and increased speed of production on hardening, brazing, annealing, forging or melting jobs. *Ohio Crankshaft*

1158. Induction Heating
"Induction Heating" presents case histories of increased production, reduced space, lower costs. *Westinghouse*

1159. Industrial Planning
Book 127 on planning expansion, remodeling or modernization of plant. *Continental Industrial Engineers*

1160. Inspection Stamps
16-page catalog of letter, figure and inspection stamps, marking dies and numbering machines. *Dickey-Grabler*

1161. Instruments
"Tomorrow Is Today" is a new brochure telling of the many contributions of instruments to industrial processing. *Minneapolis-Honeywell*

1162. Ion Exchange
24-page discussion of ion exchange resins and applications. *Rohm & Haas*

1163. Iron-Nickel Alloys
32-page bulletin on austenitic iron-nickel alloys having special thermal expansion or thermoelastic characteristics. *International Nickel*

1164. Laboratory Furnaces
Series of data sheets give full information on complete line of laboratory furnaces for numerous metallurgical operations. *Boder Scientific*

1165. Laboratory Furnaces
Folder describes and illustrates tubular furnace for use in tensile testing, and control panels. *Marshall Products*

1166. Leaded Steels
Folder on lead-bearing, cold finished bars which machine about 80% faster than B1113. *LaSalle Steel*

1167. Lithium in Copper
Data available on effect of lithium on electrical conductivity and porosity of copper and its alloys. *Metalloy Corp.*

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1168. Lockseam Tubing
Blueprint of size ranges of round or oval lockseam tubing in a wide range of metals. *H & H Tube and Mfg.*

1169. Low-Hydrogen Electrodes
Comparison chart of brand names of 16 manufacturers of low-hydrogen electrodes. *Arcos*

1170. Low-Temperature Tests
Bulletin MC-1 on cryostat that maintains a test chamber from room temperature to within 2° of absolute zero. *Arthur D. Little*

1171. Low-Temperature Tests
62-page bulletin on equipment for low-temperature tests. *Bowser Technical Refrigeration*

1172. Lubricant
Uses of colloidal graphite for hot metalworking operations (deep piercing, forging, stretch forming and wire drawing operations). *Acheson Colloids*

1173. Machining
Bulletin gives 23 case histories on performance of cutting oils in various machining operations. *E. F. Houghton*

1174. Machining Copper Alloys
32-page booklet gives cutting speeds, feeds, rakes, clearances for more than 40 copper alloys. *American Brass*

1175. Machining Titanium
Article on recommended practices for machining titanium, from first issue of "Titanium Review". *Rem-Cru Titanium*

1176. Magnesium Applications
60-page book gives 54 case studies on uses. *Dow Chemical*

1177. Magnesium Finishing
See review on page 21. *Dow Chemical*

1178. Magnesium Melting
Bulletin describes use of fabricated Amera-Mag steel crucibles in melting of magnesium alloys. *American Tank & Fabricating*

1179. Malleable Iron
Metallurgy, treatment, and properties of malleable iron described in Reprint 51-B. *Surface Combustion Corp.*

1180. Martempering of Gears
Article gives case histories on martempering of aircraft gears. *Ajax Electric*

1181. Mechanical Cleaning
76-page catalog 210 simplifies selection of power brushes; contains numerous illustrations of various types of brushes in operation. *Osborn Mfg.*

1182. Mechanical Testing
Bulletin 501 on table-model universal testing machines for tension, compression, flexure, shear and transverse tests. *National Forge*

1183. Melting Furnaces
8-page Bulletin 560 describes stationary and tilting types of two-chamber melting furnaces. Applications to all types of casting. *Lindberg Engineering*

1184. Melting Furnaces
24-page book on electric furnaces for steel mills and foundries. Many photographs of furnaces in action. Table of types, sizes, ratings. *American Bridge*

1185. Metal Analysis
Brochure on Quantometer, which furnishes pen-and-ink records of quantitative spectrochemical analyses with extra copies. *Applied Research Labs.*

1186. Metal Cutting
64-page catalog No. 28 gives prices and describes complete line of rotary files, burrs, metalworking saws and other products. *Martindale Electric*

1187. Metal-Cutting Saws
Circular saw blades described, with data on standard sizes and sharpeners. *Motch & Merryweather*

1188. Metal-Cutting Shears
16-page Catalog 2011 on pivoted-blade shears for cutting metal up to 20 ft. long and 1.25 in. thick. *Cleveland Crane & Engineering*

1189. Metal Spraying
Folder on processes and uses; metallizing for mechanical repairs and corrosion protection. *Metalweld*

1190. Metallograph
Research metallograph, described in catalog E-240, furnishes four different accurate images of same sample for complete identification with bright field, dark field or polarized light. *Bausch & Lomb*

1191. Metallograph
6-page folder describes universal and compact metallograph with built-in camera. *Wm. J. Hacker*

1192. Micrographic Equipment
6-page bulletin on a universal camera microscope giving plate magnifications from 4 to 3000 ×. Full details on optics and accessories included. *Opplem Co.*

1193. Microhardness Tester
Bulletin describes the Kentron microhardness tester. *Kent Cliff Laboratories*

1194. Modulus Determination
Data sheet on equipment for determination of modulus of elasticity by sonic method that measures resonance frequency of masses weighing up to 1500 lb. *Electro Products Laboratories*

1195. Multi-Point Recorder
Folder ND-46-33A on instrument for indicating and recording data from as many as 160 thermocouples. *Leeds & Northrup*

1196. Ni-Carb Treatment
Literature on Ni-Carb (carbonitriding) treatment for surface hardening. *American Gas Furnace*

1197. Nondestructive Testing
Bulletin entitled "Industrial X-Ray for Nondestructive Inspection and Testing". *Keleket X-Ray*

1198. Nondestructive Testing
Data on electronic inspection equipment and comparators for sorting. *Magnetic Analysis*

1199. Nonferrous Melting
12-page bulletin on eight types of gas furnaces for melting nonferrous metals. *Bellevue Industrial Furnace*

1200. Nonferrous Tubing
Bulletin on seamless, brazed and lockseam tubing in brass and copper. *H & H Tube and Mfg.*

1201. Oil Burner
Bulletin C-220 on design and operation of new low-pressure-air atomizing oil burner. *Bloom Engineering*

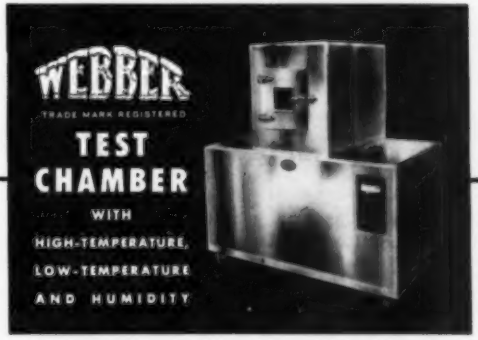
1202. Oil Quenching
Catalog V-1146 on self-contained oil cooling equipment. Detailed solutions to typical problems. Selection tables for volume of oil required and oil recirculation rates. *Bell & Gossett*

1203. Open Hearth Control
Data Sheet 6.4-9 on instrumentation for controlling reversal of open hearth furnaces. *Minneapolis-Honeywell*

1204. Optical Pyrometer
New Catalog 85 on self-contained, direct reading optical pyrometer. Specifications, operating procedures. *Pyrometer Instrument Co.*

1205. Oven Furnaces
Bulletin 200 on gas oven furnaces of improved efficiency. Complete specifications. *American Gas Furnace*

1206. Paint Adhesion
Literature on Granodine coating for improving paint adhesion on steel, iron and zinc. *American Chemical Paint*



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1207. Pearlitic Malleable
Folder 12 on properties of pearlitic malleable iron. *Belle City Malleable Iron*

1208. Peening
Bulletin on use of cut wire shot for peening and cleaning. *Park Chemical*

1209. Periodic Chart
Latest periodic chart of the elements. Green and black, 11 by 14 in., official 1952 data. *General Electric*

1210. Photography
12-page Bulletin MPU on universal camera for low-power photography on film or plates. *Gamma Instrument Co.*

1211. Pickling
Bulletin on heating and agitating pickling solutions. *Ozark-Mahoning*

1212. Pickling Solutions
Bulletin 36 on D-scale RS, substitute for liquid pickling. *Magnus*

1213. Plating
Bulletin CR-110-5 describes equipment, bath, operating conditions and control of high-speed chromium plating process. *United Chromium*

1214. Plating Control
Data on instruments for control of plating solutions and on other plating equipment. *Demott Industries*

1215. Plating Rectifiers
Bulletin on selenium rectifiers for electroplating and anodizing. *Wesley Block & Co.*

1216. Plating Solutions
16-page bulletin on plating Pb, Sn, Fe, Cu, Ni, Cd, In from fluoborate solutions. *General Chemical*

1217. Plating With Rhodium
Directions for rhodium plating, with reference to use as replacement for usual plating metals. *Baker & Co.*

1218. Polishing
Catalog A-60 on polishing lathes for speeds up to 3600 rpm. *Hammond Machinery*

1219. Polishing and Buffing
Bulletin "Straightline Automatic Polishing and Buffing" describes machines for polishing and buffing. *Acme Mfg.*

1220. Polishing Materials
20-page booklet describes and includes samples of emery, aluminum oxide and silicon carbide papers, and 12 polishing cloths. Trade names, particle sizes. *Buehler, Ltd.*

1221. Portable Potentiometer
12-page bulletin 270 describes portable potentiometers in a selection of ranges up to 1.6 volts. *Rubicon*

1222. Potentiometer Indicators
16-page Bulletin 305-4 on single point, multiple point and portable potentiometric temperature indicators. *Foxboro*

1223. Potentiometers
Article in Rubicon Notes gives technical data on semi-precision potentiometers. *Rubicon*

1224. Pots
Bulletin N-1 on pressed steel pots for lead, salt, oil tempering and metal melting. *Eclipse Fuel Engineering*

1225. Powder Metallurgy
Data sheet on zinc stearate as a lubricant in powder metallurgy. *American Cyanamid*

1226. Precision Casting
12-page illustrated booklet on precision casting with emphasis on the most widely used equipment and supplies. Check list of applications in various fields. *Alexander Saunders & Co.*

1227. Precision Castings
12-page booklet, "Pour Yourself an Assembly", describes wide range of ap-

plications and alloys for precision casting. *Precision Metalsmiths*

1228. Precision Castings

Bulletin 706 on the Mercast frozen mercury process of investment casting. *Alloy Precision Castings*

1229. Precision Castings

Illustrated folder, "Microcast Case Histories", describes microcasting applications for both industrial and defense requirements. *Austenal Labs.*

1230. Precision Grinding

8-page article on oils for precision grinding, from Notebook. *D. A. Stuart*

1231. Precision Strip

Thin-gage and clad metals, as well as precious metal strips, wire and powder, which are still available, are listed in Bulletin 9-B. *American Silver*

1232. Pre-Plated Metals

16-page fabrication handbook on preplated metals, ferrous and nonferrous. *American Nickeloid*

1233. Presses

20-page catalog 17-D on straight-side, double-crank presses. Specifications of different models. *E. W. Bliss*

1234. Protective Chemicals

Reference list of rust proofing, paint-bonding and metal protective chemicals for fabricators of steel, zinc and aluminum. *American Chemical Paint*

1235. Protective Finish

Booklet "Protective Finishes and Heat Treating Salts for Metals". *Mitchell-Bradford*

1236. Protective Finish

24-page book on Pentrate process that applies deep black finish to steel. Applications, characteristics, and processing equipment. *Heatbath*

1237. Pump for Liquid Metal

Bulletin 876 on electromagnetic pump for pumping liquid metal having electrical resistance equal to or less than stainless steel. *General Electric*

1238. Pyrometer Wires

Color codes, calibration symbols, elements of couple and extension wires for ISA, U. S. Military and Aeronautical specifications. *Thermo Electric Co.*

1239. Pyrometers

12-page Bulletin 713 on indicating and controlling pyrometers. Functional diagrams of installations. *Gen. Electric*

1240. Pyrometers

Bulletin on portable hand pyrometers for 0 to 2500° F. *Claud S. Gordon*

1241. Pyrometric Switches

12-page Catalog 5800 illustrates and describes rotary, key and plug-type pyrometric switches. Applications, dimensions, mountings and circuits. *Minneapolis-Honeywell Regulator Co.*

1242. Quench Tank Conveyor

8-page bulletin on continuous quench tank conveyor and other production equipment. *Klaas Machine & Mfg.*

1243. Quenching Additive

8-page brochure tells in detail how carbon steel often can replace alloy steel when additive is used in the quenching oil. *Aldridge Industrial Oils*

1244. Recirculating Furnaces

16-page Bulletin 81 describes and illustrates heat treating furnaces for ferrous and nonferrous parts and other heat treat equipment. *Despatch Oven*

1245. Recording Potentiometer

14-page folder on simplified single-point recorder of the potentiometer type. *Weston Electrical Instrument*

1246. Refractories

20-page booklet gives technical information on super refractories. Charts, tables and application data. *Refractories Div., Carborundum Co.*

1247. Refractories

52-page book on background, materials used, and design of various types of refractory enclosures for furnaces, soaking pits, catalyst regenerators. *M. H. Detrick Co.*

1248. Refractories

Form 1409 on fused stabilized zirconia refractory for furnace linings, metal melting, other uses. *Norton Co.*

1249. Refractories

12-page brochure on products for casting special refractory shapes and for gunning and troweling applications, for services to 3000° F. *Johns-Manville*

1250. Refractory Cement

Bulletin discusses refractories and heat-resistant concrete. *Lumnite Div.*

1251. Refractory Mixes

16-page bulletin No. 315 on properties and applications of sillimanite super-refractory ramming mixes and furnace patches. *Chas. Taylor Sons*

1252. Resistance Welding

12-page bulletin SP351 on nine basic types of resistance welders. *Federal Machine and Welder*

1253. Rheostats for Plating

Bulletin 500 on cast-grid type of tank rheostats for control of electroplating. *Columbia Electric*

1254. Roll Temperatures

Bulletin 405 describes new measuring head for recording and controlling roll surface temperatures. *Foxboro*

1255. Roller Dies

Data sheet gives information on roller dies for forming tubes, pipe and cold rolled shapes. For all roll forming machines. *American Roller Die*

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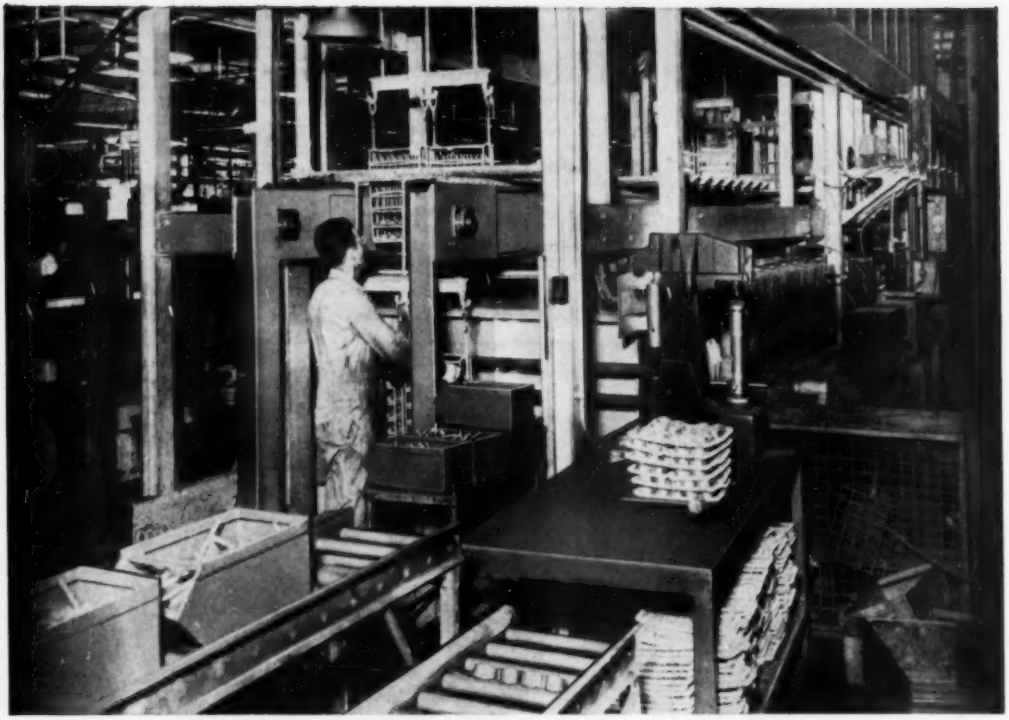

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Folder on 3 x 5 in. flat and wire mills. *Stanat Mfg.*

1257. Rust Prevention
16-page book on applications of vapor-wrapper method of rust prevention. *Nox-Rust Chemical*

1258. Rust Proofing
Literature on Permadine for rust proofing ferrous metal parts. *American Chemical Paint*

1259. Salt Bath Brazing
4-page data folder on salt baths for brazing of steel, stainless, and non-ferrous metals. *Heatbath*

1260. Salt Bath Control
Data sheet 5.2-5 describes instrumentation for temperature control of salt baths in heat treatment of high speed steel. *Minneapolis-Honeywell*

1261. Salt Bath Furnaces
Illustrated folders give data on salt bath furnaces for batch and conveyorized work. *Upton Electric Furnace*

1262. Salt Baths
28-page booklet deals with heat treatment, carburizing, bath maintenance, safety precautions. *American Cyanamid*

1263. Salt Spray Testing
Bulletin on lucite salt spray testing cabinet. *Singleton Co.*

1264. Saws
Catalog 49 describes 35 models of metal-cutting saws, including fast, automatic production saw, hydraulic hack saws and widely used small shop saws. *Armstrong-Blum Mfg.*

1265. Scale Removal
Article on continuous hydride descaling at plant of Sharon Steel Corp., from "Modern Metal Finishing". *DuPont*

1266. Seamless Tubing
52-page "Handbook of Seamless Steel Tubing". Production and properties. 26 pages of data. *Timken*

1267. Selective Carburizer
Bulletin on "No-Carb" for selective carburizing and prevention of decarburizing on high alloy steels during heating for hardening. *Park Chemical*

1268. Selective Heat Treating
Reprint 73 describes new method of selective heat treating in a salt bath. *Ajax Electric*

1269. Set Screws
20-page catalog and reference book on set screws. *Set Screw & Mfg.*

1270. Shaker-Hearth Furnace
Bulletin 850 on shaker-hearth furnace for bright carburizing, carbonitriding, hardening. *Hevi Duty Electric*

1271. Shell Molding
Data sheet on new synthetic resin for bonding shell molds. *Borden Co.*

1272. Shell Molding
8-page technical bulletin on shell molding process for stainless steel. *Cooper Alloy Foundry*

1273. Shot Peening
Catalog describes selection and use of shot and grit for cleaning and peening. *Cleveland Metal Abrasive*

1274. Silver Brazing
48-page manual on all aspects of silver brazing applications and problems. *American Platinum Works*

1275. Silver Brazing Fluxes
Bulletin T-8 on use of fluxes for silver alloy brazing. *Handy & Harman*

1276. Soaking Pit
Bulletin on the construction and performance of soaking pit to reduce fuel used by 40% while almost doubling amount of steel heated. *Loftus Eng'g.*

1277. Solder Stripper
Data sheet on alkaline material for stripping tin, lead and lead-tin without attaching base metal. *Enthone*

1278. Soldering Aluminum
Article on techniques and materials for soldering aluminum. *Reynolds Metals*

1279. Soldering Equipment
8-page brochure on soldering and brazing equipment describes new Mogul soldering gun and shows its applications to production-line soldering and brazing. *Metallizing Co. of America*

1280. Solvent Cleaning
24-page brochure on medium-pH cleaner for following solvent degreasing or other precleaner. *Northwest Chemical*

1281. Specification Key
Guide to Government specifications for phosphatizing, rust proofing and paint bonding chemicals. *American Chemical Paint*

1282. Specimen Cut-Off Machines
Folder describes complete line of cut-off machines. Five models for samples from ½ to 3 in. dia. *Buehler Ltd.*

1283. Spectrographs
52-page guide to spectrographic apparatus for metallurgical and general chemical analysis. *Jarrell-Ash*

1284. Spectrophotometer
Bulletin B-211 on junior-size spectrophotometer for identifying and measuring solution constituents. *Harshaw*

1285. Spray Booths
Bulletin has 15 pages of photos, diagrams and information on hydro-whirl spray booths in all sizes and arrangements for manual or automatic spraying. *Peters-Dalton, Inc.*

1286. Spring Steel
Handbook describes various spring steels and gives tolerance tables, heat treatment and physical property tables and fabrication data. *A. R. Purdy Co.*

1287. Spring Wire
Detailed information on oil tempered spring wire to help solve coiling, knotting, forming and twisting problems. *Pittsburgh Steel Co.*

1288. Springs
Information on compression, torsion, flat, extension and special springs. *John Evans Sons, Inc.*

1289. Springs Tester
Bulletin on precision tester and its use in statistical quality control of springs. *Torrington Mfg.*

1290. Stabilized Stainless
Extensive table of data showing results of tensile, close bend and reversed bend tests on three heats each of titanium-stabilized and columbium-stabilized stainless steel. *Metal Progress*

1291. Stainless Castings
Reference charts give specification designations, analyses, properties and heat treatments for 17 standard corrosion and heat resistant alloy castings. *Lebanon Steel Foundry*

1292. Stainless Fabrication
133-page book covers welding, riveting, soldering, joint design, machining, forming, annealing, pickling, finishing of stainless steels. *U. S. Steel*

1293. Stainless Fasteners
20-page catalog provides detailed product specifications to aid in selecting and ordering stainless steel fastenings. *Star Stainless Screw*

(Continued on p. 32-A)

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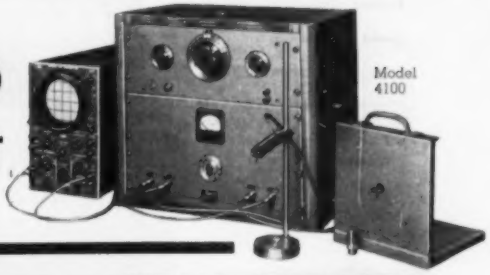

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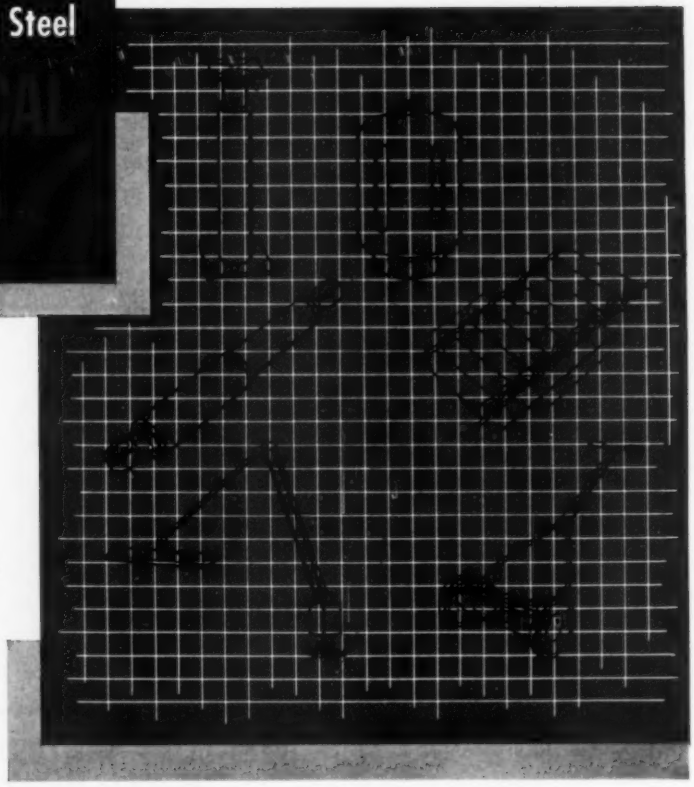

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32-page book on corrosion resistance of stainless steels. 18 tables on tests in acid, neutral and alkaline solutions. *International Nickel*

1296. Stainless Steel
12-page book, "Type 430 Stainless Steels as Alternates of the 18-8 Series". Fabrication data, four pages of comparative corrosion ratings for Types 430, 302 and 316. *Republic Steel Corp.*

1297. Stainless Steel
20-page book on specific applications of stainless steel in the pulp and paper industry. *Crucible Steel*

1298. Stainless Steel Powder
Bulletin 2 gives tensile, hardness and density properties for a new 18-8 stainless powder as function of mesh size, sintering temperature and compacting pressure. *Vanadium-Alloys Steel*

1299. Steel, Low-Alloy
8-page folder on N-A-X low-alloy, high-strength steels lists properties and test specifications. *Great Lakes Steel*

1300. Steel, Low-Alloy
Booklet on Hi-Steel, with nearly twice the working strength of ordinary steels plus impact resistance. *Inland Steel*

1301. Steel and Aluminum Piston
6-page data book on the steel-belted aluminum piston. Construction and advantages. *Thompson Products*

1302. Steel Tubing
48-page Handbook F-3 on fabricating and forging steel tubing. Bending, shaping, cutting and joining operations described. *Ohio Seamless Tube*

1303. Steels, Spring
Spring steel catalog offers 652 sizes of hardened and tempered spring steels, and 133 cold-rolled and bright annealed sizes in stock. *Sandvik Steel, Inc.*

1304. Straightening Coil Stock
Equipment described for feeding and straightening coil stock for stamping, blanking or shearing. *F. J. Littell*

1305. Straightening Tube
8-page Bulletin 52 on experience at seven plants with rotary straighteners for tubular products. *Mackintosh-Hemphill*

1306. Straightening Wire
Bulletin 52-AA describes straightening machine for wire in size range from 1/16 to 1 in. diameter, at speeds up to 200 ft. per min. *Medart Co.*

1307. Straight Chrome Stainless
12-page book on fabrication and use of Type 430 stainless steel. *Sharon Steel*

1308. Stress Analysis
Revised edition of "Photoelastic Stress Analysis" shows the engineer why this method is effective for solving problems of stress distribution. *Eastman Kodak*

1309. Subzero Freezer
4-page folder on portable freezer, 110-volt a.c., operating to −180° F., for shrink fitting, hardening, stabilizing and testing. *Webber Appliance*

1310. Subzero Thermometer
Information on recording thermometer for as low as −200° F. *Dickson*

1311. Subzero Treatment
Advantages of low-temperature metal treatment are described in a new 8-page folder. Processes covered are for stabilization, increasing tool life and shrink-fit assembly. *Deepfreeze Distributing*

1312. Super High Speed Steel
Technical data folder on molybdenum, 8% cobalt high speed steel for use at speeds 20 to 25% greater than with ordinary high speed steel. Heat treatments, protective coatings and uses. *Firth Sterling, Inc.*

1313. Surface Cleanliness
Bulletin 40 describes device to measure surface electrical resistance as criterion for effectiveness of a cleaning process. *Weltronic*

1314. Surface Grinding
54-page guidebook on use of disk grinders for grinding flat surfaces. *Gardner Machine*

1315. Surface Hardening
Booklet on nonpoisonous, nonexplosive and nonflammable surface hardening compounds. Illustrations and engineering charts. *Kasenit Co.*

1316. Surface Temperatures
Pyrocon bulletin on hand-held thermocouple-type instrument for measuring and indicating surface temperatures at exact locations. *Illinois Testing Labs.*

1317. Tank Liners
Data on hard vinyl material for corrosion resistant tanks and tank linings for electroplating. *American Lucoflex*

1318. Tank Liners
Corrosion data on Koroseal tank linings in contact with plating baths and other corrosive solutions. *Metalweld*

1319. Temperature Contr
Bulletin PC-1 on indicating a trolling instrument. *Wheelco*

1320. Temperature Contr
8-page bulletin on new tempe control unit that automatically tors up to 20 temperature points ute, with excess-temperature a cut-out. *Illinois Testing Labs.*

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New catalog G-17 describes te ture control instruments. *Burl struments, Inc.*

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Catalog of pyrometer supplie data on thermocouples, protectio other accessories. *Arklay S. Richa*

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"Basic Guide to Ferrous Meta a plastic laminated wall chart *Claud S. Gordon*

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Common metals and alloys and identified. Photomicrograph yses, hardness data for compa teaching. *A. I. Buehler*

1325. Testing
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Booklet on Reflectoscope te ultrasonic vibrations penetrate feet to "see" internal defects tigue cracks in primary and metal parts. *Sperry Products*

1327. Testing Equipmen
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1328. Testing Machine
New universal testing mac 12,000-lb. capacity is presented letin 336. *Baldwin-Lima-Hamil*

1329. Testing Machines
32-page catalog on hydraulic machines. 10 models describe accessories. *Riehle*

1330. Testing Machines
Universal testing machines an ment are diagramed, descrit illustrated in 20-page Bull *Tinius Olsen Testing Machine*

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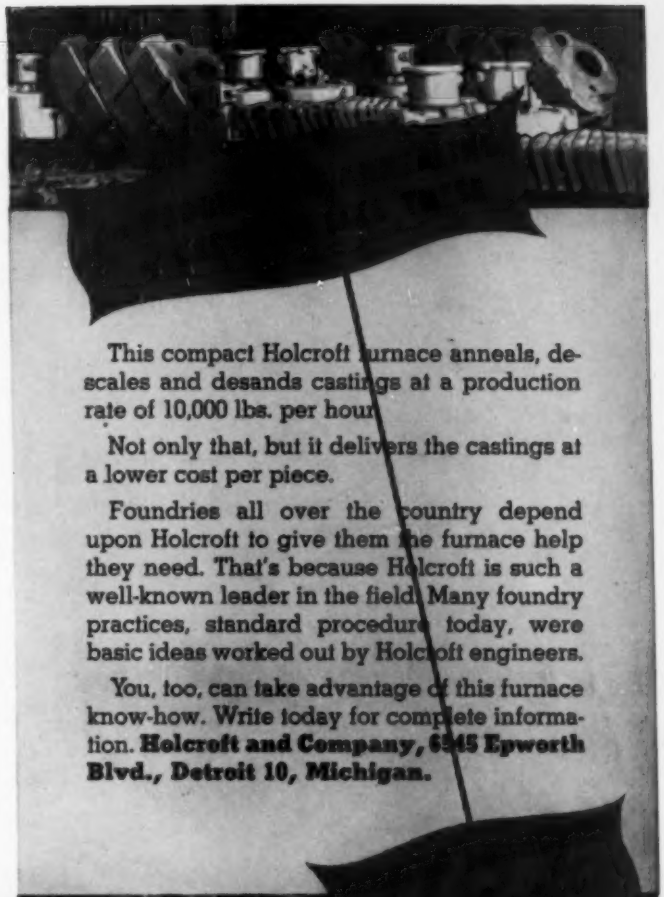

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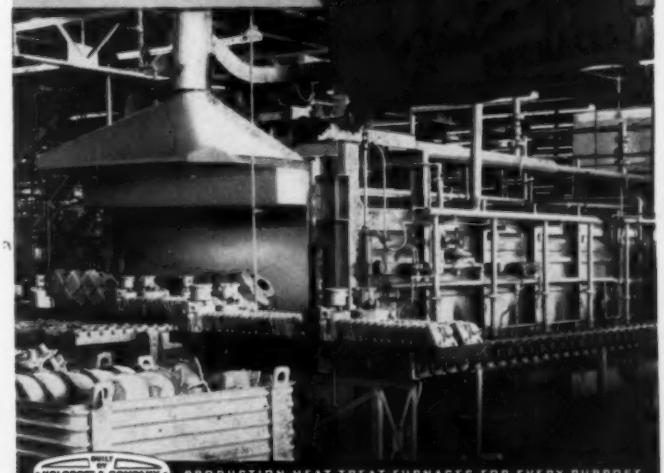

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Paris 8, France

1332. Thermocouples

20-page Bulletin 714 on thermocouples, protecting tubes and wells, insulators, leads, connectors, heads. *Gen. Electric*

1333. Thermocouple Accessory

Bulletin TC-1 on accessory for sealing unshielded thermocouple wires in any chamber operating at pressures from 15,000 psi. down to full vacuum. *Conax*

1334. Thermocouple Data

42-page Bulletin TC-9 on thermocouples, radiation detectors, resistance bulbs, accessories. *Wheelco*

1335. Thermocouples and Pyrometer Accessories

56-page book comprising a User's Manual, illustrated Buyers' Guide with specifications and prices and thermocouple calibration data. *Bristol Co.*

1336. Tin

24-page book on production, consumption, uses of tin. *Malayan Tin Bur.*

1337. Titanium

30-page data book on properties of commercially pure and alloy titanium, melting, forging and rolling. 16 charts and micros; 4 hardness conversion curves for titanium. *Republic Steel*

1338. Titanium and Zirconium

16-page bulletin, "The Hydrimet Process", describes titanium and zirconium metal and hydride, and other metallurgical hydrides. *Metal Hydrides*

1339. Tong Ammeters

Bulletin on tong test ammeters, a.c. or d.c., for instant current measurements without breaking circuit or touching conductor. *Columbia Electric*

1340. Tool and Die Steels

26-page book on six oil and air hardening steels for high-production tools and dies. Many uses illustrated. *Bethlehem Steel*

1341. Tool Heat Treating

Information on "Sure-Wear" process for heat treating high-speed cutting tools. *LR Heat Treating Co.*

1342. Tool Steel Color Guide

Color guide to estimate the temperatures of heated steels has heat colors on one side and temper colors on the other side. *Bethlehem Steel*

1343. Tool Steel Selector

Twist the dial of the 9-in. circular selector and you can read off the tool-steel for your application. *Crucible Steel*

1344. Tool Steel Selector

Selector is handy chart featuring general and heat treating data on non-deforming, water hardening, shock-resistant, hot work, high speed tool and hollow die steels. *A. Milne & Co.*

1345. Tool Steels

Full information on uses, compositions and heat treatment of carbon and carbon-vanadium tool steels. *Vanadium-Alloys Steel Co.*

1346. Tool Steels

Stock list of available tool and die steels. *Reliable Steel*

1347. Tubes and Bars, Steel

New stock list on 52100 tubing, bars, ring forgings. *Peterson Steels*

1348. Turbo Compressors

12-page bulletin 126-A on application of turbo compressors to oil and gas-fired equipment used in heat treating, agitation, cooling, drying. Performance curves, capacities. *Spencer Turbine*

1349. Vacuum Pump

Bulletin on air pressure or vacuum pumps for laboratory. Performance and size specifications. *Eberbach Corp.*

1350. Vanadium Recovery

6-page article, "Recovery of Vanadium and Other Alloys in the Acid Electric Furnace". *Vanadium Corp.*

1351. Vapor Degreasing

Bulletin 6521 on vapor degreaser. Drawings, specifications, applications. *Randall Mfg.*

1352. Volt-Ammeter

Folder on clamp-type, hand size instrument for use on a.c. to 600 amp., 600 v. *Columbia Electric Mfg.*

1353. Washing Machines

12-page bulletin on washing and drying machines; conveyor, cabinet, drum and vertical types described. *Industrial Washing Machine*

1354. Water Purity

Folder on electronic device for testing purity of water and controlling flow. *Barnstead*

1355. Welding

"Improved Design for Welding" describes the economies of good welding design as compared to haphazard design methods. *Linde Air Products Co.*

1356. Welding and Cutting

64-page catalog of welding and cutting equipment, supplies, and accessories. *Southern Oxygen Co.*

1357. Welding Armor Plate

Booklet discusses new low-hydrogen ferritic electrodes for welding armored ships and tanks. *Arcos Corp.*

1358. Welding Electrodes

Application chart for stainless, alloy and nonferrous electrodes. *Weldwire*

1359. Welding Electrodes

See review on page 23. *Gen. Electric*

1360. Welding Equipment

Cadweld process and complete list of arc-welding accessories are described in catalog. *Erico Products, Inc.*

1361. Welding Pressure Vessels

Reprint describes procedures for welding stainless, stainless-clad and copper alloy pressure vessels and refinery components. *Air Reduction*

1362. Welding Tool Steel

Brochure on use of tool steel electrodes in rebuilding worn or damaged areas of tools and dies. Tempering curves for weld deposits from five types of tool steel electrodes. *Alloy Rods*

1363. Weldments and Castings

24-page book, "Facts About Weldments and Castings", gives basic engineering facts about plate fabrication vs. castings. *Acme Tank & Welding*

1364. Wire Fabrication

16-page handbook on applications and fabrication of wire. Engineering data, forming methods, 12 case histories. *E. H. Titchener & Co.*

1365. Wire Straightening

Bulletin 52-C describes precision machine for straightening small wire with extreme accuracy. Applies to round wire 0.007 to 0.125 in. diameter of ferrous or nonferrous metal. *Medart Co.*

1366. X-Ray Equipment

"Industrial X-Ray Accessories", on equipment, including chemicals, darkroom accessories, filing equipment, processing tanks, dryers and radiation instruments. *Picker X-Ray*

1367. X-Ray Inspection

Bulletin 400-520 on jib-crane unit for applications where horizontal and vertical travels of standard tubestand are inadequate. *Westinghouse*

1368. X-Ray Supplies

48-page catalog of industrial X-ray supplies and accessories. *X-Ray Dept., General Electric*

1369. Zinc Die Castings

Folder on small parts applicable to die casting. *Dollin*

1370. Zirconium

Mechanical and corrosion properties of pure ductile zirconium; also new price schedule. *Foote Mineral*

1371. Zirconium

26-page booklet gives physical, mechanical and chemical properties, present and potential uses, supply and prices of zirconium. *Titanium Alloy*

October, 1952

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Latrobe to Display Mammoth Bar of High Speed Steel

New Development to be Featured at A. S. M. Show

Latrobe Steel Company, well known producers of quality tool steels, will exhibit at the Philadelphia A. S. M. Exposition (October 20-21) a bar of "DESEGATIZED" high speed steel — 10 inches in diameter and 10 feet long, weighing approximately 3,000 pounds.

This is the largest bar of high speed steel ever made and is free of carbide segregation throughout.

Carbide segregation and its harmful effects have long been a problem in the manufacture and heat treatment of high alloy tool steels. Latrobe Steel Company, who introduced "DESEGATIZED" high speed steels and high carbon-high chromium die steels in 1946, states that it is now possible to manufacture sizes free of carbide segregation to meet any current and foreseeable needs for these steels.

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simple, low-cost proportional control *with the* new Pulse *PYR-O-VANE* Controller

FOR ANY heating process which needs proportional control for close temperature regulation . . . but which does not require the more complete facilities of a recording instrument . . . it will pay you to investigate the new Pulse *PYR-O-VANE* Controller.

This compact, non-recording instrument affords true proportional control . . . holds temperature within tight tolerances that can't be matched by two- or three-position control. It's ideal for furnaces, plastic extruders, injection molding machines and countless other electrically heated and fuel fired units having fast heating rates and relatively small heat capacity. The time-proportioning action of this *PYR-O-VANE* Controller supplies heat in exact proportion to the furnace needs . . . overcomes the tendency of furnaces to cycle about the desired control point.

The low cost of the *PYR-O-VANE* Controller brings accurate, proportional control within the reach of any process. Your local Honeywell engineer will be glad to discuss how this new instrument can improve the control performance in your plant. Call him in today . . . he is as near as your phone.

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How pulse control regulates heat input

Like on-off control, pulse-type time-proportional control turns the source of heat alternately on and off. But unlike on-off control, this method varies the percentage of time that heat is on. When more heat is needed, the controller increases the length of the "on" periods; when less is needed, it decreases them. In this manner, it provides continuous, accurate adjustment of average heat input . . . proportioned to the heat demand of the process. Simple adjustment of proportional band and cycle time custom-fits this new *PYR-O-VANE* controller to the heating process.

These features assure versatility...easy maintenance

ADJUSTABLE PROPORTIONAL BAND . . .
easily set on calibrated dial.

ADJUSTABLE CYCLE TIME . . .
six values from 3 to 72 seconds, readily obtained by changing gears.

SIMPLIFIED MAINTENANCE . . .
plug-in units can be removed and replaced in a few seconds.

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unaffected by ambient temperature, humidity, line voltage, distance from sensing element.

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available for use with thermocouples or Radiamatic pyrometers in many standard ranges.

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readily installed, for flush or surface mounting.

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● *Important Reference Data*

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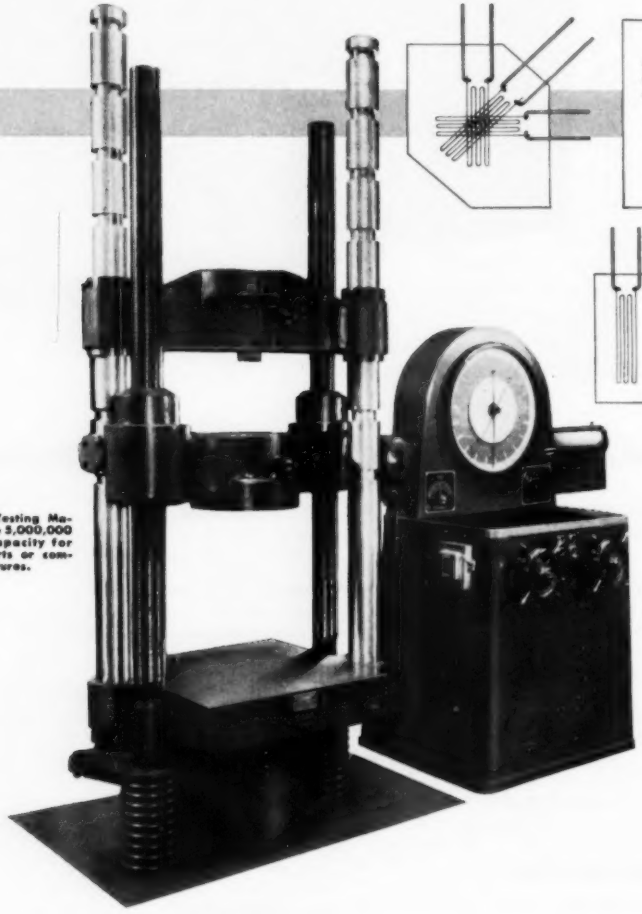
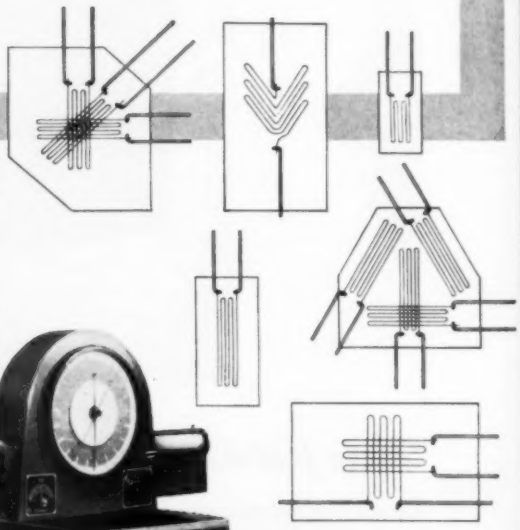
to *improve* the mechanical design

If you are now redesigning your products—or in the midst of a continuing program of improvement—you have a real need for one or all of these Baldwin testing devices. Designed by names famous wherever material testing is done, each is a versatile scientific tool that will enable you to anticipate the reaction of materials under hard usage—and design accordingly.

Whether you are setting up a complete new testing laboratory or merely expanding your present facilities, Baldwin can supply the equipment—standard or special.



Universal Testing Machines up to 5,000,000 pounds capacity for testing parts or complete structures.



Baldwin SR-4 strain gages are used not only to measure static or slowly varying strains, but also to measure strains resulting from impact loads, and dynamic strains up to 30,000 cycles per second.

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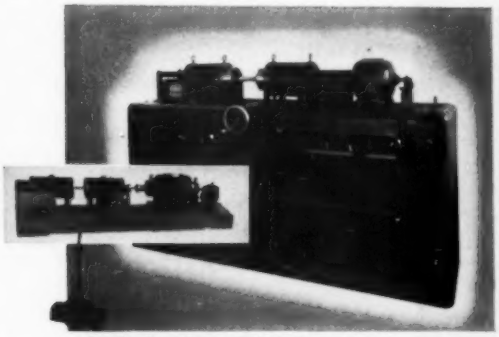
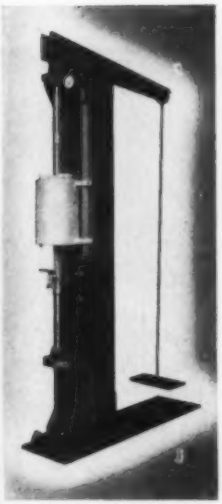
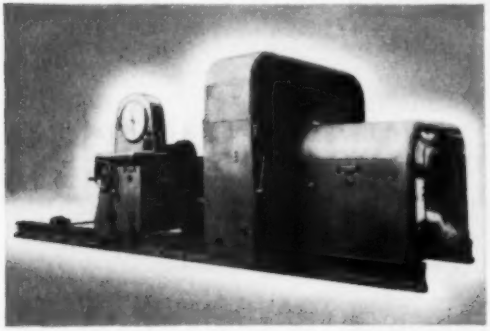


Rotating Beam Fatigue Machines for bending moments up to 10,000 inch-pounds.

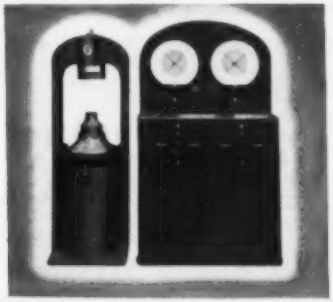
Pendulum-type Impact Machines in combination capacities from 1 foot-pound up to 240 foot-pounds.



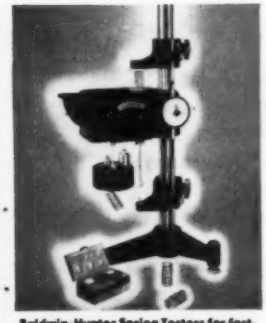
High-temperature Creep Testing Machines for creep rupture, relaxation, constant strain rate, etc.



Torsion Testers of all sizes, capacities, speeds to meet individual specifications.



Compression Testers for loads up to 300,000 pounds for concrete cylinders and building blocks. Other machines for cement, mortars, soil with readability down to 5 pounds per dial division.



Baldwin-Hunter Spring Testers for fast, accurate testing of compression and extension springs with loads up to 10 pounds.

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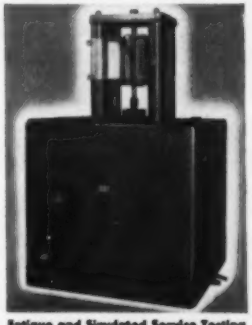

Fatigue and Simulated Service Testing Machines—the most complete line ever offered, from 25 pound to 20,000 pound capacity machines.

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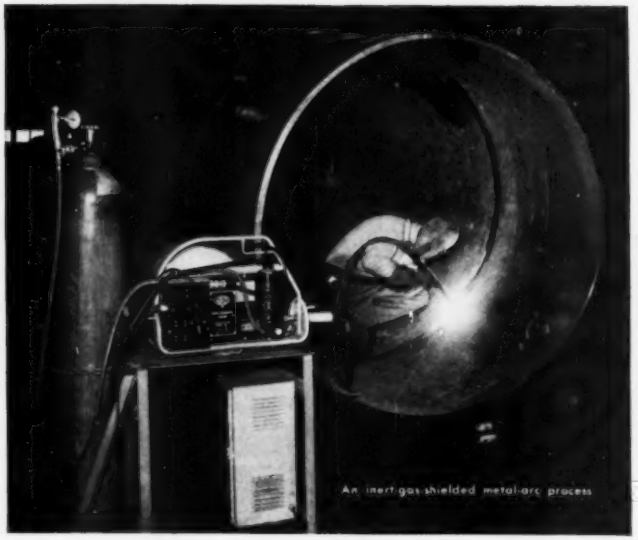

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for hard-to-join metals

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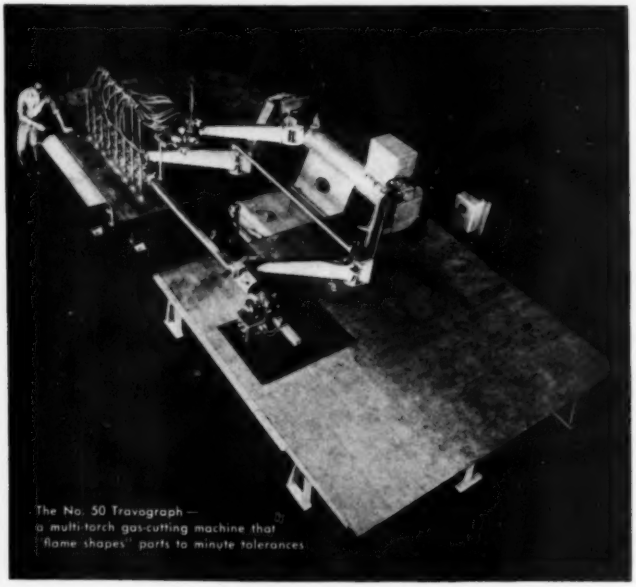

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TRAVOGRAPH® CUTTING

for mass producing intricate shapes

- "Electronic bloodhound" tracing device accurately reproduces template or outline drawings
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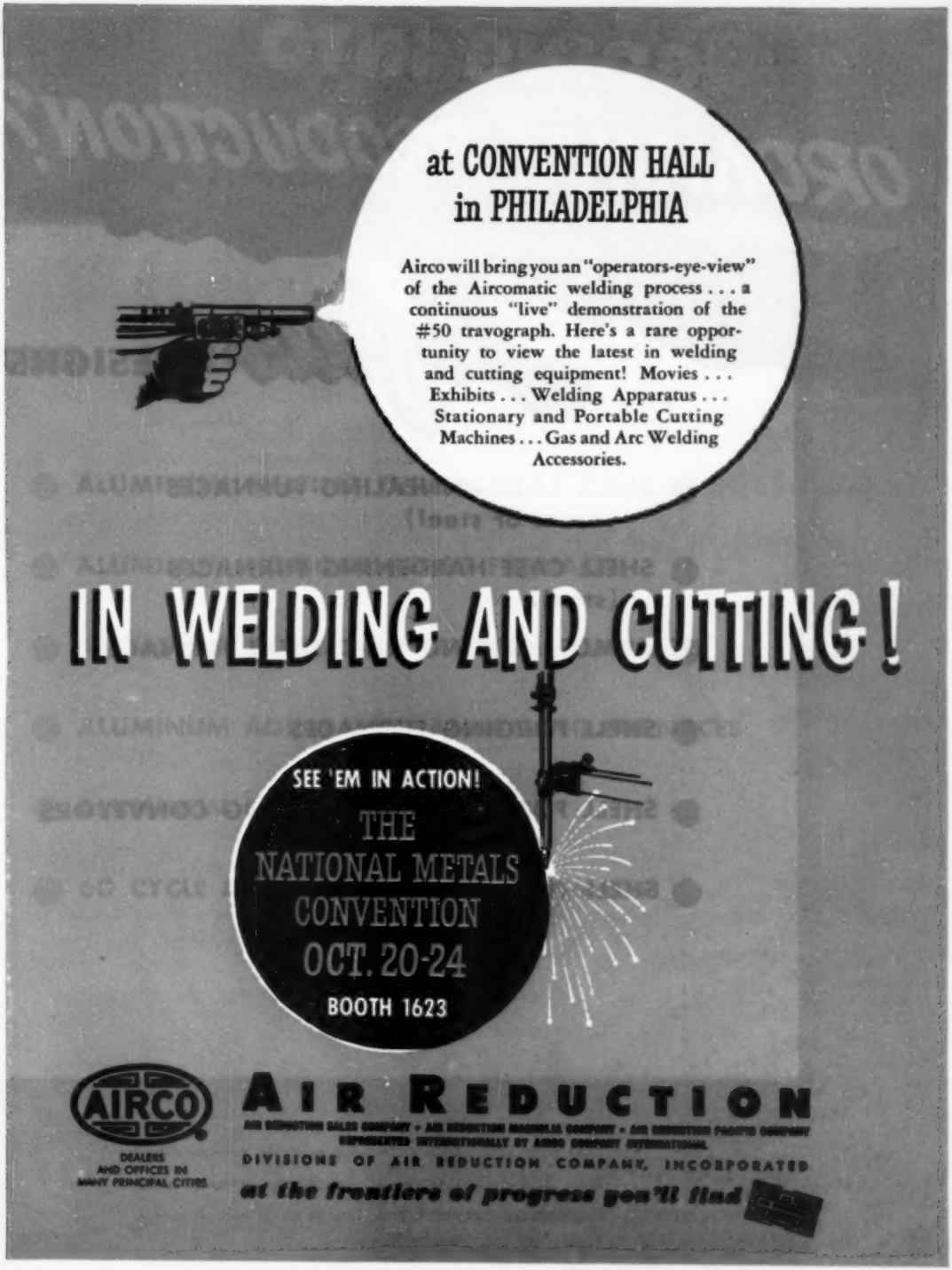
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Loftus DESIGNS
● SHELL CASE ANNEALING FURNACES (brass or steel)
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* Last year, Loftus Engineering Corporation designed and built $24 million worth of industrial furnaces. Loftus Engineering can serve you. Get in touch with us today.

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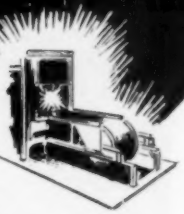

AND CONSTRUCTS:

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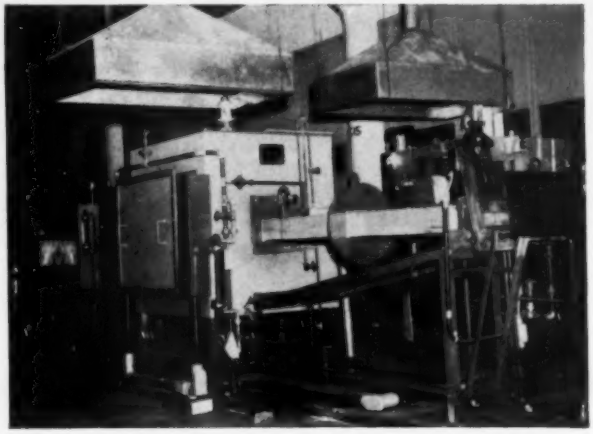
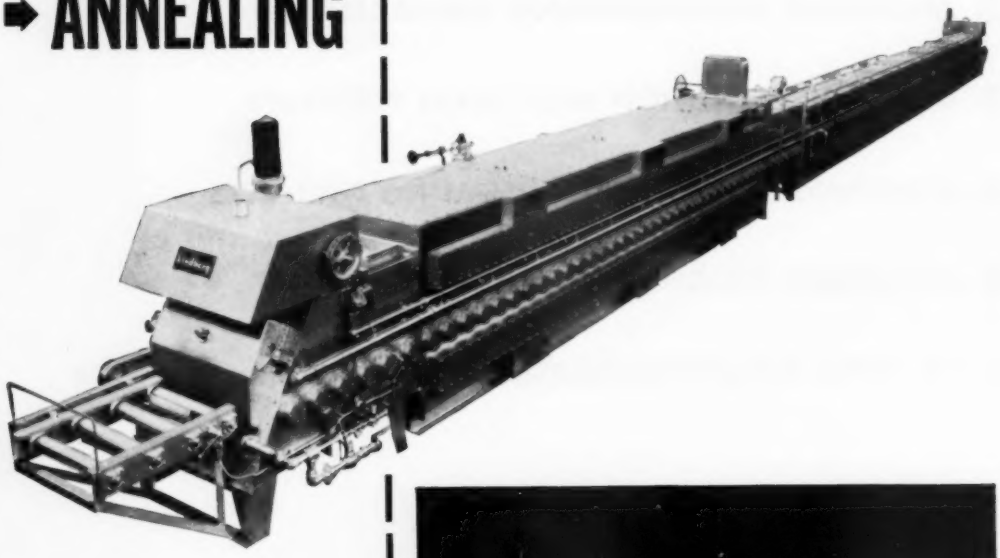
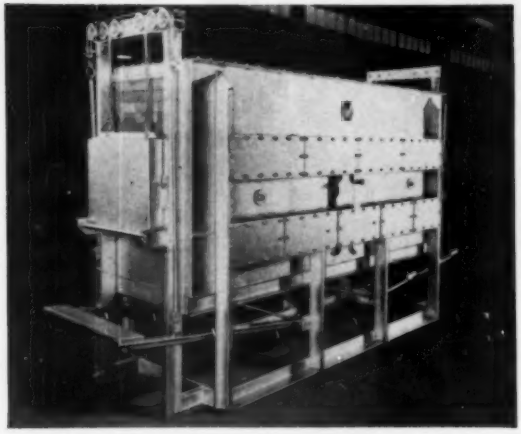


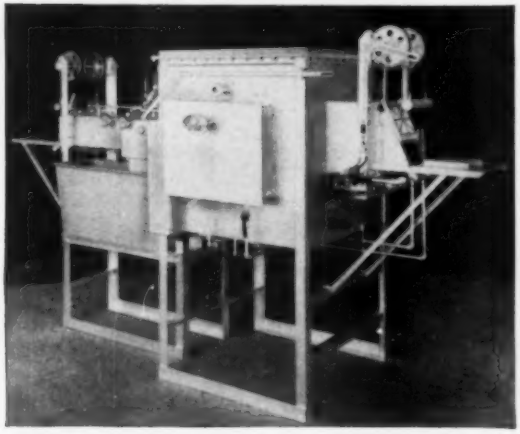
● Continuously purged with dissociated ammonia atmosphere, this furnace is used for sintering powder metal parts at temperatures up to 2200°F. GLOBAR elements have a connected load of 20 KW.



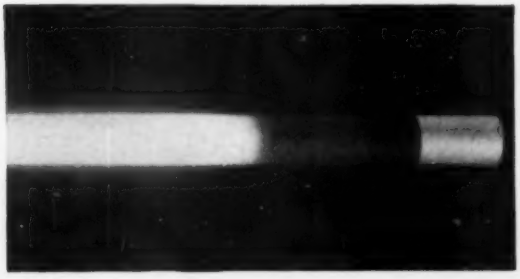
● This roller hearth continuous brazing furnace, measuring 184' from door to door and rated at 700 KW, is heated by 144 GLOBAR silicon carbide Heating Elements.



● Double door Electric forging furnace for heating billets and bar stock. Has a 12"x12" chamber 8' long. GLOBAR elements provide a maximum temperature of 2500°F.



● This continuous pusher type furnace is used for heat treating high speed steel tools. GLOBAR non-metallic heating elements contribute substantially to the efficient design and operation.



● More than thirty famous makers of electric furnaces equip their product with GLOBAR Brand silicon carbide heating elements. Scores of industries who use electric furnaces have standardized on GLOBAR elements. Consulting engineers, too, recognize the unusual advantages in furnace design and construction which GLOBAR Heating Elements make possible.

Find out for yourself the many benefits which are specifically available to you through use of GLOBAR Heating Elements by CARBORUNDUM. For detailed data, write Dept. MP 87-119.

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by CARBORUNDUM

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MP-119

KLOSTER'S "PURE ORE"

"D-C-33"

REG. U.S. PAT. OFF.

HOT WORK STEEL

Shell Drawing Mandrels made from "PURE-ORE" "D-C-33" HOT WORK STEEL

KLOSTER STEEL CORPORATION

224-228 N. JUSTINE ST. • CHICAGO 7, ILL. • PHONE HAymarket 1-3450

"Steel to Endure Must be Pure"

KLOSTER'S "PURE-ORE"

TRADE MARK REGISTERED U. S. PAT. OFFICE

FINE TOOL STEELS

THERE IS A KLOSTER PURE-ORE TOOL STEEL FOR EVERY TOOL AND DIE PURPOSE

Hundreds of Sizes

(A Section of our Chicago Warehouse)

KLOSTER STEEL CORPORATION

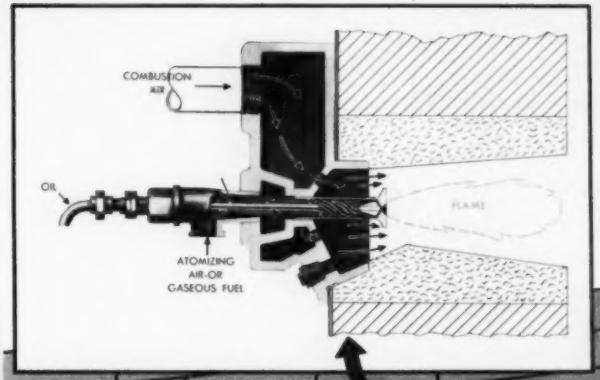
224-28 N. JUSTINE STREET — CHICAGO 7, ILLINOIS

All Phones HAymarket 1-3450

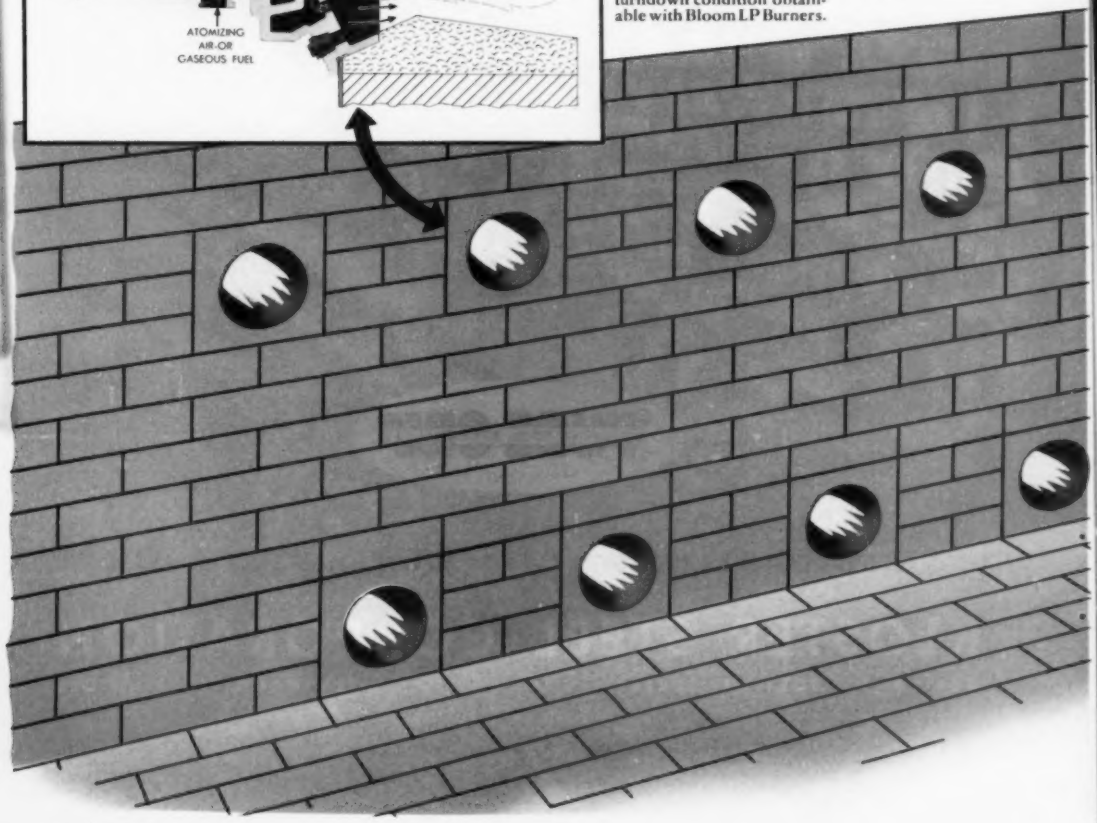
ANNOUNCING

The BLOOM LP OIL BURNER

Low-pressure 16-oz. air atomizing

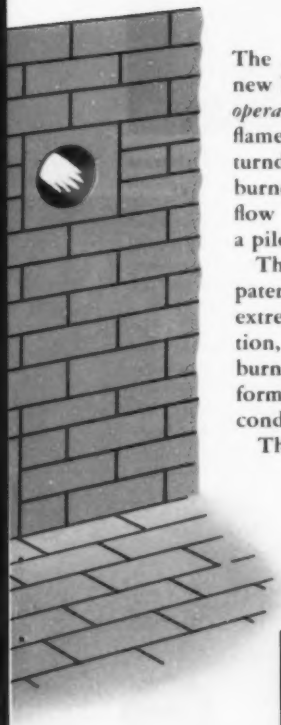


Section through LP Burner and view of typical furnace wall, showing the ideal low-turndown condition obtainable with Bloom LP Burners.



Designed to solve 3 problems:

WIDE RANGE TURNDOWN on oil operation
FLAME STABILITY at extremely low fuel input
ACCURATE BURNER CONTROL without intricate adjustments



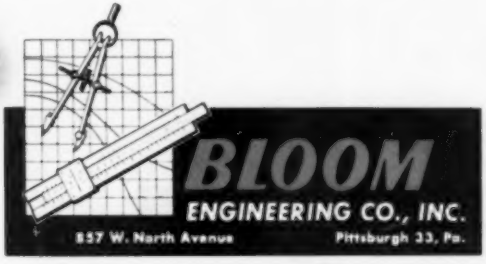
The outstanding feature of the unique new Bloom LP Oil Burner is *dependable operation at extremely low input.* Stable flame conditions are maintained over a turndown range of 10 to 1, and the burner operates satisfactorily with oil flow as low as ½ gal. per hour without a pilot.

Through the combination of the Bloom patented Flame Retention Nozzle and an extremely efficient method of atomization, (using 16 oz. air pressure), this burner provides highly satisfactory performance over a wide range of heating conditions.

The Bloom LP Oil Burner has no moving parts. No individual burner adjustments need be made to change heating conditions. Control is easily and quickly accomplished through the customary zone control fuel valves.

With the Bloom LP Oil Burner you get:

- ★ A wide range of turndown—10 to 1
- ★ Dependable operation at flows as low as ½ gph.
- ★ Complete, accurate control using zone control valves; rather than complicated mechanical linkages for burner adjustment
- ★ Equal distribution of fuel between individual burners without delicate burner adjustments. Maximum flexibility of furnace operation



WRITE for new bulletin describing in greater detail the design and operation of the Bloom LP Oil Burner. Ask for bulletin C-220.

This Super Stainless Gives You New Freedom From Corrosion!

When you're faced with a severe corrosion problem, investigate the super corrosion resistance of Carpenter Stainless No. 20. This sulphuric acid resisting Stainless can often reduce shutdown time and add substantially to equipment life.

If you are familiar with this alloy in its cast form, known as Durimet 20*, you can appreciate Carpenter No. 20's superior resistance to sulphuric acids, plating and pickling solutions, mixed acids, etc. Now that Carpenter has solved the problem of producing this Stainless in rolled forms such as bars, wire, strip and tubing, the alloy is enabling industry to add months—even years to equipment life.

Of course, because of No. 20's high nickel content, there isn't always enough to "go around". Yet many engineers tell us they're planning now to use No. 20 as soon as possible to improve corrosion resistance in their products and reduce shutdowns. For help in your product planning work get the new Carpenter Stainless No. 20 Book. In addition, start now to discover for yourself the far-reaching advantages of No. 20. We'll be glad to provide test coupons and work with your engineering staff.

Imagine What Corrosion Resistance Like This Can Mean To You!

The problem here was to find a material that would stand up in nozzles used to fill storage batteries with electrolyte. Special fixtures were used to handle 12% sulphuric acid (specific gravity 1.080) at temperatures from 70°F to 130°F. Hard rubber nozzles broke frequently—and shutdowns for replacement often ran as high as 30 minutes. Even 18-8 Stainless nozzles, while solving the breakage problem, corroded so badly they lasted only *2 weeks* (see 18-8 nozzle on right of photo). Then Carpenter No. 20 was put to work. After they had been in use for *many months*, nozzles made from No. 20 showed no signs of corrosion (see No. 20 nozzle on left of photo).

*Carpenter Stainless No. 20 is licensed under The Duriron Company, Inc., U.S. Pats. 2,134,670; 2,185,987 and 2,200,208.

Carpenter

STAINLESS NO. 20

Another Carpenter First!

The Carpenter Steel Company · 133 W. Bern St. · Reading, Pa.
Export Department: The Carpenter Steel Co., Port Washington, N. Y.—"CARSTEELCO"

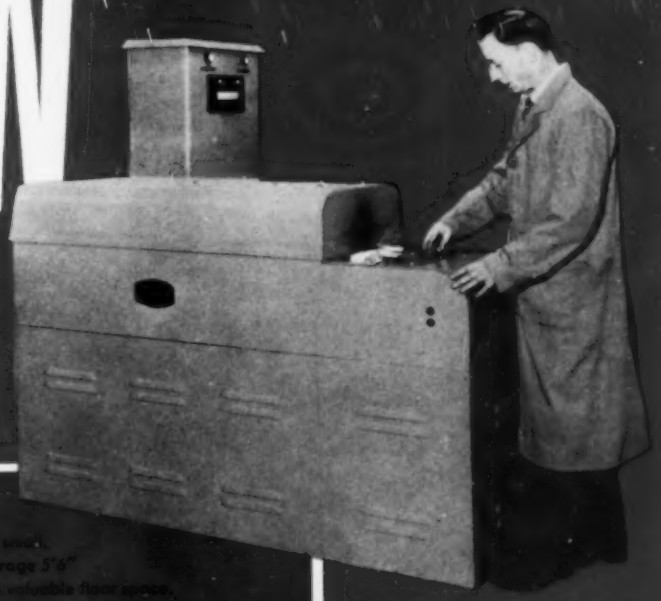
Pioneers in Improved Tool, Alloy and Stainless Steels Through Continuing Research

LINDBERG at the Metal Show . . .

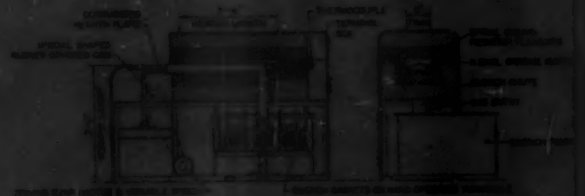
Be sure to visit the Lindberg exhibit at the Metal Show, Convention Hall, Philadelphia, October 18-24, 1952

NEW

THE LINDBERG-EFCO SHAKER HEARTH FURNACE



Saves floor space . . . the Lindberg-Efco furnace is small, just about the size of the average 5'6" desk—it will help you to save valuable floor space.



Original designs for the Lindberg-Efco Shaker Hearth furnace are by a Lindberg affiliate, the Electric Resistance Furnace Co., Ltd., Weybridge, England.

Here's a small electric furnace designed and built in England by our associates over there, which has been unusually successful in a great many plants. It's being used for bright hardening or sintering items such as needles, watch parts, fish hooks, instrument parts, and many other small machined parts.

Easy installation, easy maintenance . . . The Lindberg-Efco furnace is a package unit, complete with built in quench tank. All your installation man has to do is make connections between the furnace, switchgear and the main supply. Maintenance and inspection of heating elements and muffle is simple—the top section is hinged and can be opened with ease in a moment's time.

Lindberg Engineering Company

2450 W. Hubbard Street, Chicago, Illinois

LINDBERG FURNACES

LINDBERG at the

see the new LINDBERG CARBONITRIDING FURNACE

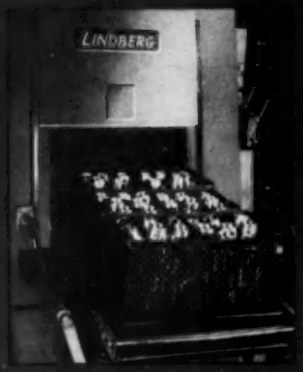
Here's the greatest advance in industrial furnace design and construction since Lindberg introduced the Cyclone forced convection tempering furnace back in 1938!

Change tubes like the blades in your razor! It's easy to change the new thin-wall tubes—just lift 'em out and hang new ones in place . . . all in a matter of minutes.

Metal Show . . .

Be sure to visit the Lindberg exhibit at the Metal Show,

Convention Hall, Philadelphia, October 18-24, 1952



A 325 lb. load of CRS sleeves. Carbonitrided .010 to .015" 90 minutes in heating chamber. Temperature, 1650° F.

A 600 lb. load of CRS bar nuts. Carbonitrided .003 to .005", 60 minutes in heating chamber. Temperature, 1400° F.

Yes, you must see the new Lindberg Carbonitriding Furnace. It's many furnaces in one . . . it's easy to maintain . . . it's a self-contained unit.

Check these important construction features . . . features that will improve production quality and volume, and reduce production costs.

Many furnaces in one . . . Furnace atmosphere is provided by the Lindberg "Hyen" endothermic atmosphere generator that is easily adjustable to supply different atmospheres not only for carbonitriding, but also for carburizing, carbon restoration, bright hardening or annealing and normalizing. For annealing and normalizing the heated charge cools in the same chamber used for purging.

Easy to maintain . . . Instead of old style, heavy, unwieldly, horizontal radiant tubes . . . new gas-fired, lightweight tubes (only 29 pounds) are used. They're simple to change . . . turn off the gas . . . get on top the furnace . . . lift out the old tube . . . hang a new one in its place . . . and the thin, rolled metal tubes actually last longer!

Quench tank pit unnecessary . . . Your Lindberg Carbonitriding Furnace is self-contained, including a built-in pitless quench tank . . . thus you avoid costly excavation and piping. But more important, this built-in quench tank minimizes distortion . . . quenching takes place within the furnace structure, by means of a vertically operated elevator. Heated charges are never exposed to the air . . . as is the case when work is transferred from the heating chamber to a separate quench tank. Uniform case depth is assured because each charge automatically remains at heat the same length of time.

Purge chamber . . . A specially designed chamber, built immediately above the quench tank and in front of the heating chamber, receives work load for purging prior to heating.

A 150 lb. load of CRS screws. Carbonitrided .003 to .005", 45 minutes in heating chamber. Temperature, 1550° F.

For full details ask for Bulletin 241

Lindberg Engineering Company . . . 2450 W. Hubbard Street, Chicago, Illinois

LINDBERG FURNACES

LINDBERG at the Metal Show

Be sure to visit the Lindberg exhibit at the Metal Show, Convention Hall, Philadelphia, October 18-24, 1952

The new Lindberg High-Frequency 50 KW Induction Heating Unit.

see the LINDBERG 50 KW INDUCTION HEATING UNIT

This new 50 KW Lindberg high frequency, induction heating unit is built to provide more than 50 KW at 450,000 cycles per second on a 100% duty cycle basis.

If your heating and fabricating operations call for production brazing, soldering, hardening, annealing, stress relieving, hot forming, forging or shrink fitting, a Lindberg induction heating unit can better your production picture . . . reduce costs . . . and reduce floor space requirements. The rugged "machine tool" construction of these units, plus the fool-proof "checklite" system, insures dependable, uninterrupted 24-hour-a-day production.

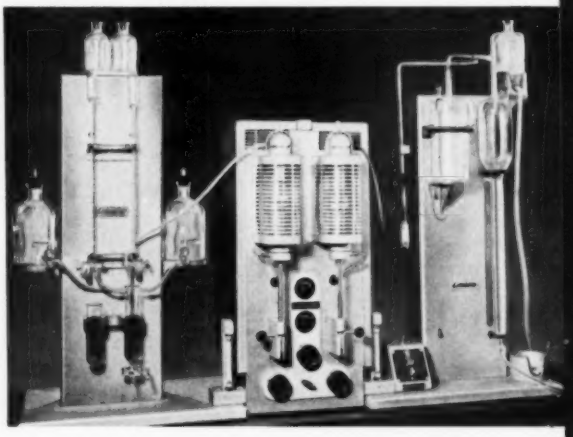
5, 10, 25 and 50 KW sizes—
Ask for Bulletin No. 1440.

see the new LINDBERG SULFUR DETERMINATOR

. . . for the determination of sulphur in ferrous materials by combustion according to the method established by ASTM (method No. E30-47).

The new Lindberg Sulphur Determinator was specifically designed for use with the Lindberg "H-F" combustion unit . . . but it's adaptable for use with resistance element type combustion furnaces, and other types of induction heating combustion units.

For additional information on the Lindberg Sulfur Determinator, together with the Lindberg "H-F" combustion unit, ask your laboratory dealer for bulletins 1000 and 1010. The carbon determinator is covered in Bulletin 1020.



Sulfur determinator | 2 Station "HF" unit | Carbon determinator

Lindberg Engineering Company — 2450 W. Hubbard Street, Chicago, Illinois

LINDBERG FURNACES

"The Ass in the Lion's Skin"

is a story for Cutting Fluid users

. . . with credit to Aesop, the Fable-Maker

An Ass dressed himself up in a Lion's Skin and ran about scaring the daylights out of the other farm animals. Then he tried to frighten his owner, the farmer. That was his downfall. The farmer soundly beat the stupid ass with a big stick, teaching him that he couldn't fool any sensible person by parading around as something he wasn't.

The Moral:

Different types of cutting fluids have their respective places in machining. Dressing a coolant up in a "Lion's Skin" doesn't change its capabilities. For example, if you have a difficult broaching job on a soft, tough steel *more than a "coolant" is needed.* You need the high *anti-weld* properties, the high *lubricity* and the superior temperature regulating qualities of a product like Stuart's ThredKut 99.

Stuart offers you a combination of time-tested products and wide experience in their application. You gain from this fewer rejects, longer tool life and greater production—often with *fewer* different cutting fluids in your plant. Ask to have a Stuart Representative demonstrate how he can save you time, money and material.

More Than a "Coolant" Is Needed

D. A. Stuart Oil Co. LIMITED

EST. 1865

TIME-TESTED CUTTING FLUIDS AND LUBRICANTS

2743 S. Troy St., Chicago 23, Ill.

SEND FOR BOOKLET entitled *More Than a "Coolant" Is Needed*

CLIP TO YOUR COMPANY LETTERHEAD AND MAIL

to D. A. Stuart Oil Co., Ltd., 2743 S. Troy St., Chicago 23, Ill.

Your Name .....

Title .....

AMERICAN CHEMICAL PAINT COMPANY

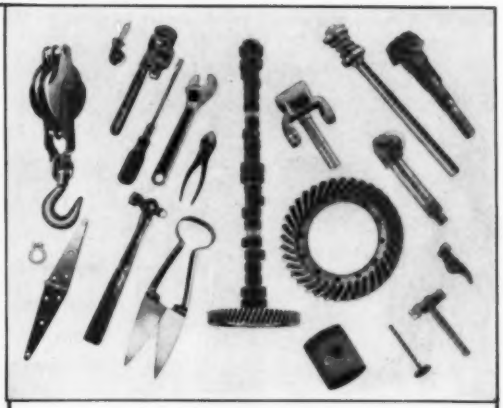
AMBLER CHEMICALS ACP PROCESSES PENNA.

Technical Service Data Sheet
Subject: RUST PROOFING WITH PERMADINE®

INTRODUCTION:

Ferrous metal parts that have been Permadized in a zinc phosphate chemical solution and then "sealed" with a rust-preventive oil such as "Granoleum" are effectively protected from rust-damage. In addition, if the surface is accidentally chipped or scratched, rusting is confined to the exposed area.

Rust proof coatings find many practical applications. During World Wars I and II most small arms were rust proofed by phosphate coating and impregnated with chromic acid and a rust preventive oil, or cutback petrolatum. This not only provided excellent corrosion resistance but also yielded a dull black non-reflecting surface. Rust proof finishes are now used widely on hardware, firearms, cartridge clips, metallic belt links, miscellaneous forgings and castings, tools, unpainted replacement machine parts, and many other similar items such as bolts, nuts, and washers.



On steel parts, "Permadine" forms a zinc phosphate coating that is non-metallic and, when suitably oiled, provides effective corrosion resistance.

"PERMADINE" DATA CHART

Type of coating	Zinc phosphate
Object of coating	Rust and corrosion prevention
Typical products treated	Nuts, bolts, screws, hardware items, tools, guns, cartridge clips, fire control instruments, metallic belt links, steel aircraft parts, certain steel projectiles and many other components
Scale of production	Large or small volume; large or small work
Method of application	Dip Barrel tumbling, racked or basketed work
Equipment notes	Immersion tanks of suitable capacity. Cleaning and rinsing stages can be of mild steel. Coating stage can be of heavy mild steel or stainless steel.
Chemicals required	"Permadine" No. 1
Pre-cleaning methods	Any common degreasing method can be used. Alkali cleaning ("Ridosol"), Acid cleaning ("Deoxidine"), Emulsion-alkali cleaning ("Ridosol"-"Ridoline"); vapor degreasing, solvent wiping, etc., are examples. Acid cleaning may need to follow other cleaning methods if rust or scale is present.
Bath Temperature	190° - 210°F.
Coating time	20 - 30 minutes
Coating weight range Mgs./Sq. Ft.	1000 - 4000
Technical Service Data Sheets	No. 7-20-1-2 T. M. No. 5

THE PERMADIZING PROCESS:

For the most effective rust proofing of large or small work in large or small production, "Permadine" is used in tanks in an immersion process, with the bath heated to 190°-210°F., coating time 20 to 30 minutes. The coated parts are then rinsed in clean water, and then in a controlled dilute acidulated solution. After drying, a suitable corrosion-resistant oil such as "Granoleum" is applied.

Operations can be carried out with the work in crates, or hung from hooks, utilizing an overhead rail and hoists. For large volume production, automatic equipment can be used to mechanize the line. Small parts can be treated in tumbling barrels.

"PERMADINE" MEETS SERVICE SPECIFICATIONS:

The protective "Permadine" finish meets U.S.A. 57-0-2C; Type II, Class B, and equivalent requirements of:

MIL-C-16232, Type II	AN-F-20
U.S.A. 51-70-1, Finish 22.02, Class B	Navy Aeronautical M-364 JAN-L-548

CHEMICALS ACP PROCESSES

WRITE FOR FURTHER INFORMATION ON "PERMADINE" AND YOUR OWN METAL PROTECTION PROBLEMS

CHEMICALS ACP PROCESSES

Uniform response to heat treatment

Another reason why you get uniform, high-quality forgings with TIMKEN® forging steels

FEWER furnace adjustments are needed when you use Timken® forging steels. You get uniform chemical composition, uniform physical properties. Result: uniform response to heat treatment—from bar to bar and heat to heat.

Your order for Timken forging steels is handled individually in our mills. We target conditioning procedure to your particular forging requirements. You can hold rejects to a minimum. And you save steel because the good dimensional tolerances of Timken steel forging bars produce uniform weight multiples with a minimum of steel lost in flashings.

To insure greater uniformity of chemical composition from heat to heat, the chemistry of Timken forging steel is closely controlled during melting by such modern devices as the direct-reading spectrometer. In just 40 seconds, it analyzes a test sample from the melt shop. And the melt shop gets a complete report less than 10 minutes after the sample is taken.

Forgings made from Timken forging steels have uniformly high ductility and resistance to impact. That's because Timken forging steels have uniform grain size after heat treatment—from bar to bar and heat to heat. Grain size and chip grain size of every shipment is checked under a microscope.

Let Timken forging steels help *you* turn out uniform, high-quality forgings day in, day out. For more information, write The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, Ohio. Cable address: "TIMROSCO".

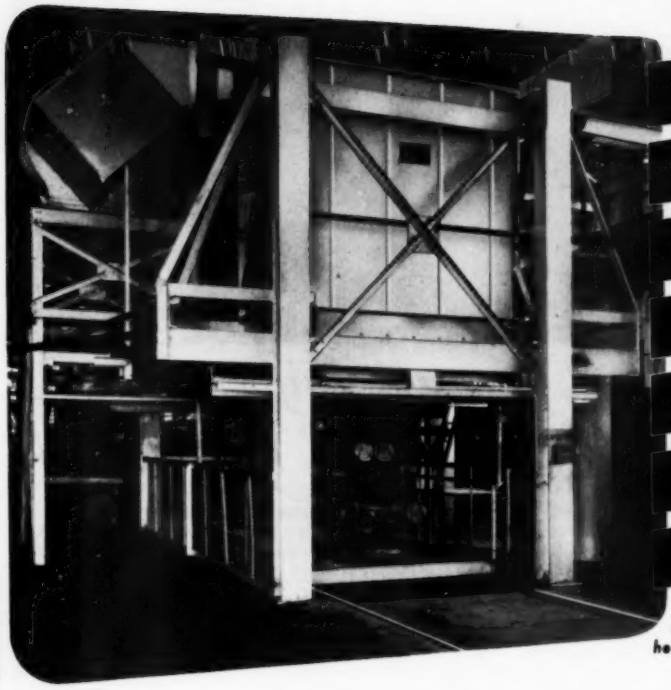
YEARS AHEAD—THROUGH EXPERIENCE AND RESEARCH

SPECIALISTS IN FINE ALLOY STEELS, GRAPHITIC TOOL STEELS AND SEAMLESS TUBING

YOUNG BROTHERS

heat treating ovens

for



- ANNEALING
- SOLUTION HEAT TREATMENT
- AGING PROCESSES
- NORMALIZING AND STRESS RELIEF
- HYDROGEN RELIEF AFTER PLATING
- PREHEATING PROCESSES
- TEMPER DRAWING

Rapid quench oven for heat treating aircraft parts

Whatever your heat treating problem, you can be sure there is a Young Brothers Oven made to handle it with maximum efficiency. Young Brothers Ovens, batch and conveyor types with accurately controlled temperatures up to 1000°, are speeding up production in every type of metal-working plant.

Through the services of Young Brothers engineers, you get the advantage of over 56 years of experience in building ovens for your specific needs. These services—available to you without obligation—will help you increase your production and cut costs. Write or call for more details.

STANDARD AND SPECIAL TYPES TO MEET PRODUCTION REQUIREMENTS AND PLANT CONDITIONS FOR ALL PROCESSES

Write for Bulletin 14T

YOUNG BROTHERS COMPANY

1829 COLUMBUS ROAD CLEVELAND 13, OHIO Established 1896

SPENCER HARTFORD TURBOS

FOR SPECIAL OCCASIONS

Standard motor driven Spencer Turbos are listed in more than 160 sizes. For special applications, there are many variations, six of which are illustrated.

Spencer Turbos range in size from 35 to 20,000 cu. ft. per min. 4 oz. to 10 lbs. and 1/3 to 1,000 h.p.

For complete description of the standard and special Turbos ask for Bulletin No. 126-A.

MIDGET
With universal motor, 35 to 75 cfm at 12 to 40 oz. pressure
GAS BOOSTER
For handling gas, acid fumes, poisonous, corrosive or explosive gases
Overhang or outboard type for coupled drive
4 BEARING
For odd frequency or other than electric motor driven
For use where it is desired to operate with steam
BELT DRIVE
AIR FILTERS
Of various types for intake of Turbo
TURBINE DRIVEN

SEE SPENCER at the AGA Booth No. 1942.

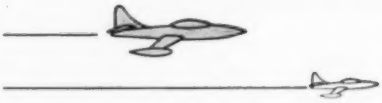
440-F

THE SPENCER TURBINE COMPANY • HARTFORD 6, CONNECTICUT

SPENCER HARTFORD

Turbine assembly of P&WA's Turbo-Wasp after 500 hours of actual operation. The Turbo-Wasp is one of the great engines for which Utica supplies blades.

UTICA HELPS



BY FORGING EXTRA "*FIGHT*" INTO TURBINE AND COMPRESSOR BLADES

The extra measure of toughness forged into jet engine blades by UTICA's methods is a vital factor in the reliability of the engine and safety of the aircraft.

With over 50 years' experience in forging, it was only natural for UTICA to be one of the first and largest suppliers of blades. And, in addition, UTICA has recently completed facilities by which the forged blades are finished to the most rigid specifications, ready for use.

UTICA's engineering, metallurgical and production staffs are among the leaders in the study and development of new and improved methods — to save time, money and materials in the production of blades of highest quality.

UTICA DROP FORGE & TOOL CORPORATION, Utica 4, New York

MAKERS OF THE FAMOUS UTICA LINE OF DROP FORGED PLIERS AND ADJUSTABLE WRENCHES

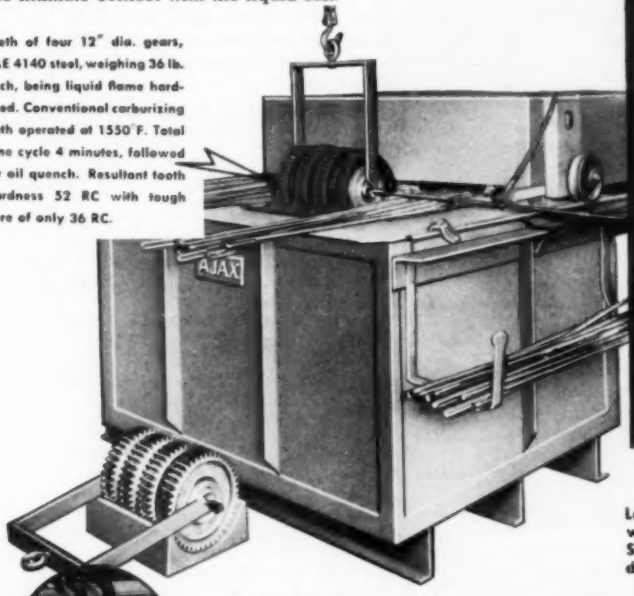
Something NEW in Selective Heat Treating . . .

LIQUID FLAME HEATING

This radically new but commercially proven application of the world renowned Ajax Salt Bath Furnace offers industry many unique advantages over any other method for selectively heating the rim or edges of circular objects, hardening teeth on gears or sprockets, and any other products that require peripheral heating.

The technique of operation is simplicity itself: Either a neutral type salt bath or a carburizing bath, heated by the internal electrode system, is maintained automatically at the required specific temperature. A number of the parts, such as gears, to be selectively heated can be mounted on a shaft within a suitable fixture which is placed over the salt bath. Only that portion of the periphery to be heated (such as the teeth) is immersed in the bath. The work is then rotated and heating is extremely rapid due to conduction by the intimate contact with the liquid salt.

Teeth of four 12" dia. gears, SAE 4140 steel, weighing 36 lb. each, being liquid flame hardened. Conventional carburizing bath operated at 1550°F. Total time cycle 4 minutes, followed by oil quench. Resultant tooth hardness 52 RC with tough core of only 36 RC.



HERE'S PROOF

Let us treat sample batches of your work without obligation in the Ajax Metallurgical Service Laboratory. Better still, come see it done yourself! Reprint No. 73 sent on request.

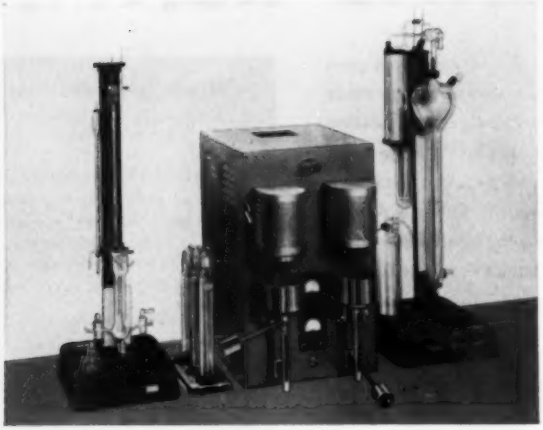
Associate companies: Ajax Electric Furnace Corp. • Ajax Engineering Corp. • Ajax Electrothermic Corp.

AJAX

OVER 4,000 INSTALLATIONS . . . more than all other salt baths combined

AJAX ELECTRIC CO., INC., 910 FRANKFORD AVE., PHILADELPHIA 23, PA.

CARBON AND SULFUR ANALYSES MADE EASIER WITH DUAL UNIT INDUCTION FURNACE



One power source serves two induction furnaces in the new Leco Model IH-15

HARSHAW

ORDER IT FROM HARSHAW SCIENTIFIC

In reality two furnaces in one, the Leco IH-15 Induction Furnace efficiently combines a single tube carbon furnace and a single tube sulfur furnace with but one power source. The use of only one power source lowers by several hundred dollars the cost of this unit as against two separate single furnaces. In operation, the power is directed to one combustion tube at a time, allowing one sample to be combusted while the other is weighed and loaded. In this way, almost the same amount of testing can be completed as if two separate furnaces were used.

The carbon side has a combustion tube with a patented jet, while the sulfur side has a special large combustion tube and a large inductor coil. If it would suit your purposes better, the IH-15 can be equipped to analyze sulfur from both sides, or carbon from both sides, at no extra cost. Once purchased, the standard model can be altered one way or the other for a small additional charge.

The design of the IH-15 is such that no grid tap switch is needed. There are no oxygen valves incorporated in the unit, but these can be purchased separately and can be mounted on the furnace or on the laboratory bench.

Having been operated with good success in many routine production laboratories, the IH-15 is now made available to you as a thoroughly tested, finished unit.

Recommended equipment list for one complete carbon and sulfur determination installation employing the IH-15.

H-15637 High Frequency Furnace IH-15	$1005.00
CARBON APPARATUS—	
H-15651 Carbon Determinator (Leco 4000)	440.00
H-15635-5 Copper Oxide Catalyzing Furnace (Leco CU-11A)	198.00
H-15635-17 Combustion Crucibles (Leco IH-10-580) (Box 1000)	50.00
H-15657-22 Combustion Accelerator (Leco 100) (Bottle 1#)	4.75
H-15657 Purifying Train (Leco 1150)	90.00
SULFUR APPARATUS—	
H-15670 Sulfur Determinator (Leco 400-1)	190.00
H-15657-20 Rubber Diaphragm Oxygen Valve (Leco 77-250) (2 required)	ea. 16.00
H-15636-17 Combustion Crucibles (Leco IH-10-800) (Box 1000)	60.00
H-15636-19 Crucible Covers (Leco IH-10-900) (Box 1000)	50.00

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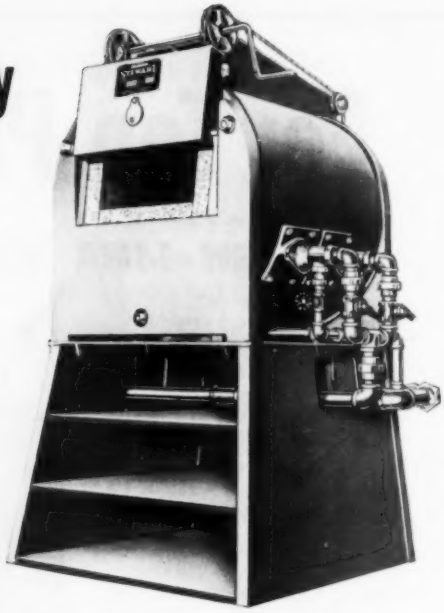

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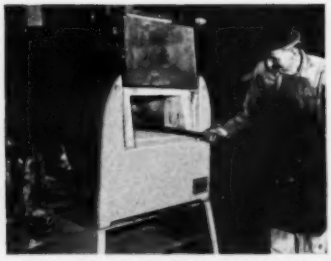
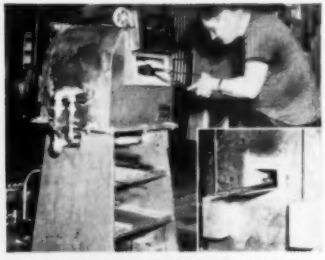


AT CARNEGIE-ILLINOIS STEEL CORPORATION, *Gary Sheet Mill, general forging and forming, cleaning, etc., are carried out at 1800°-2400°F. For shrinking operation, temperatures as low as 300°F may be used.*



AT ALUMINUM COMPANY OF AMERICA, *Chicago works, this oven is used for miscellaneous tool work. Material heat treated includes tool and dies of small sizes, shapes and weights. Special removable plug permits center heating of long bars.*

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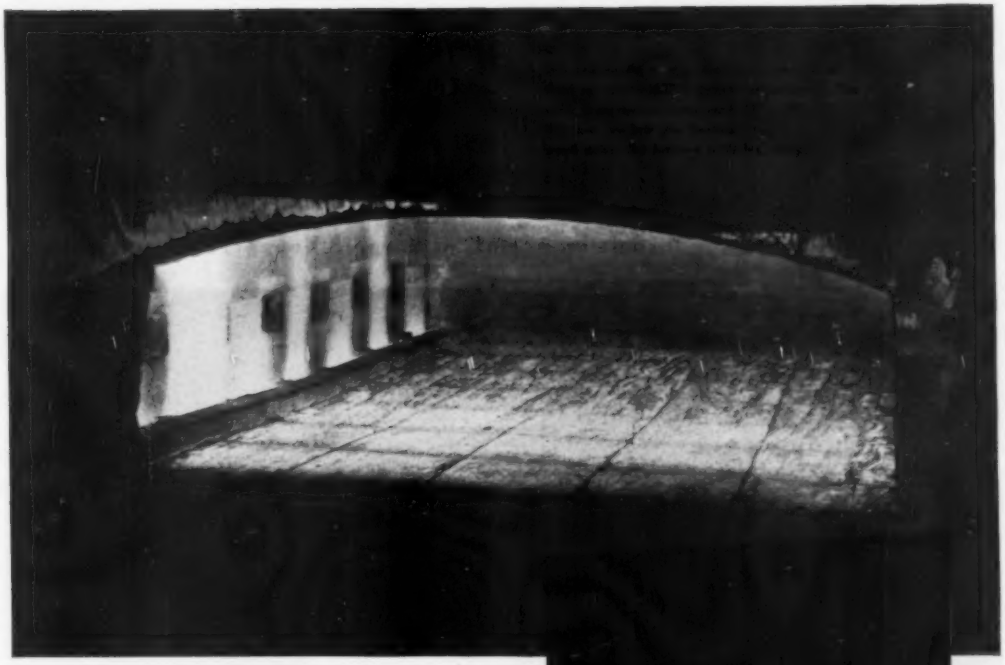

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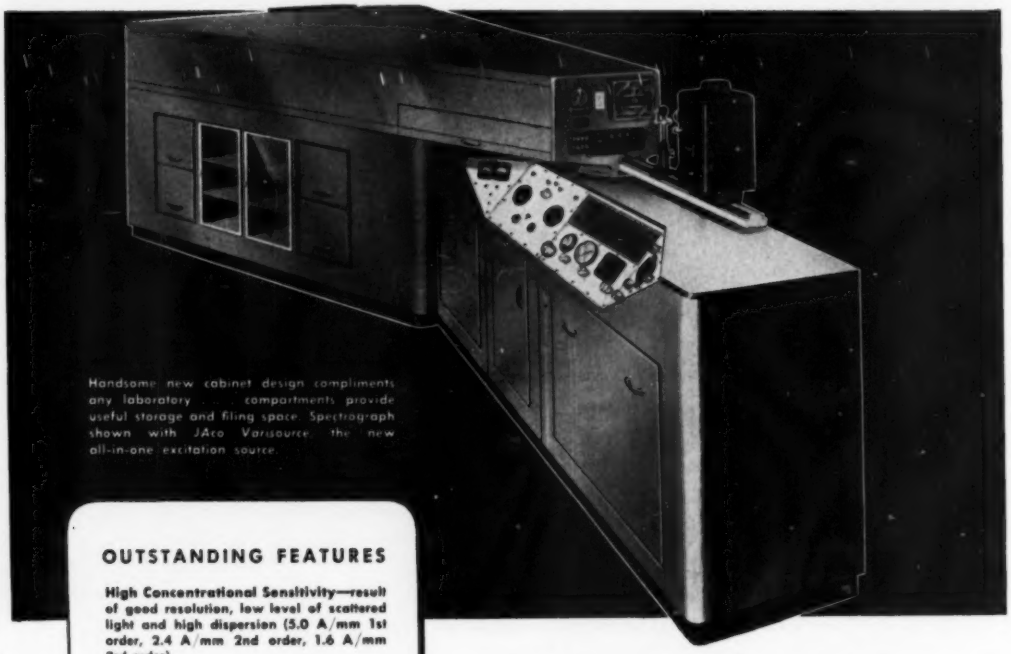

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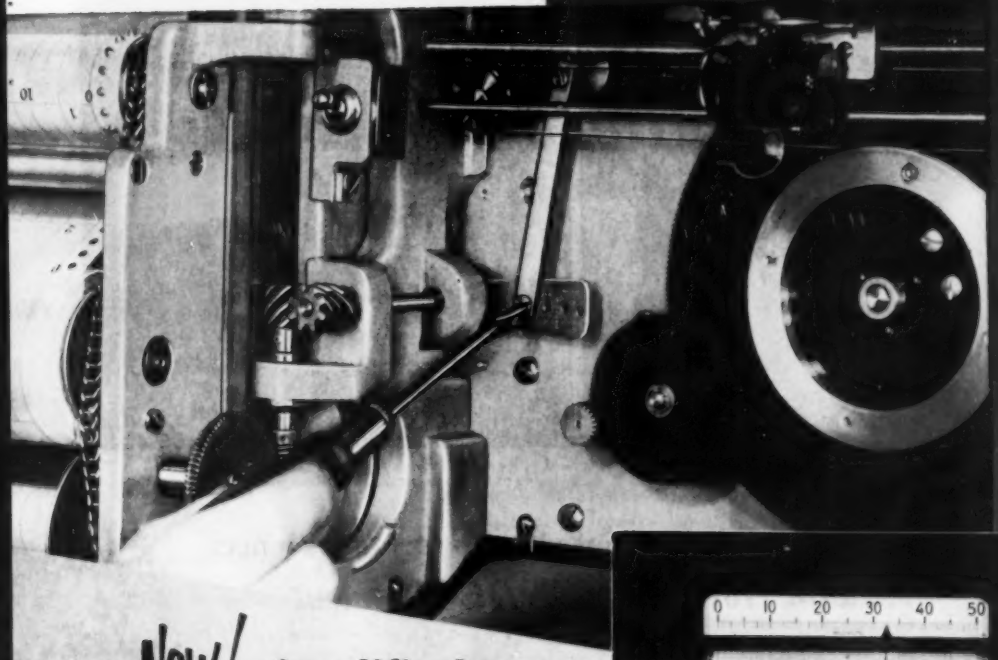
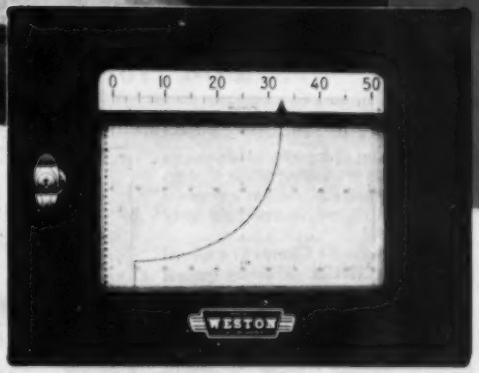
You change chart speeds this simple way





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WESTON 9130 **WESTON** *Instruments* INDICATE — RECORD — CONTROL

Left: **DESULPHURIZING LADLE** for handling gray iron being lined with a special Norton ALUNDUM* refractory cement.
Right: In operation, ALUNDUM cement lining lasts 2 to 4 times longer than other linings.

Desulphurizing ladle linings last up to 4 times longer

... *with Norton ALUNDUM cement*

How long do your present ladle linings stand the violent boiling action that results when you add sodium carbonate briquettes to desulphurize your gray iron?

Not long enough? Change to a special Norton ALUNDUM refractory cement and see what happens.

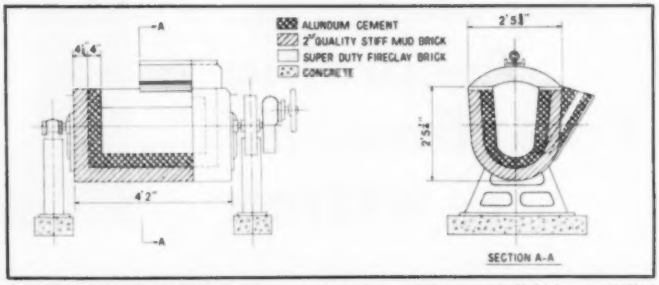
Test Shows Amazing Results

In one case, a foundry which operates a 1500 lb. capacity Whiting "U" shaped ladle for desulphurizing gray iron decided to test ALUNDUM cement. Lining life was increased 200-400%.

This foundry has now standardized on Norton ALUNDUM cement . . . and gets extra dividends in the form of easier installation, lower maintenance cost, lower over-all refractory cost.

Run a Test Yourself

Yes, why don't you test Norton ALUNDUM cement in your ladles, too? In the meanwhile, get further information from your nearby Norton representative — or write direct to NORTON COMPANY, Refractories Division, 328 New Bond Street, Worcester 6, Mass. *Canadian Representative:* A. P. Green Fire Brick Co., Ltd., Toronto, Ontario.



NORTON ALUNDUM CEMENT, in the test mentioned, was air-hammered 4" thick over 4½" of second quality stiff mud brick in the ladle and the entire spout. This was air dried overnight . . . and heated gently with a low-flame gas torch until thoroughly dried. Finally, the ladle was brought up to full heat and put into service.

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Metal Progress

Vol. 62, No. 4 • October 1952

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Technical Program

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Seminar: Modern Research Techniques in Physical Metallurgy

Saturday, Oct. 18

9:30 A.M.—Metallographic Methods

BALLROOM, BENJAMIN FRANKLIN

Optical Microscopy
by *George L. Kehl*, Columbia University

Electron Microscopy and Diffraction
by *Robert D. Heidenreich*, Bell Telephone Laboratories

Crystal Growth and Crystal Boundary Techniques
by *Bruce Chalmers*, University of Toronto

2:00 P.M.—Diffraction Methods

BALLROOM, BENJAMIN FRANKLIN

X-Ray Diffraction Techniques
by *Charles S. Barrett*, University of Chicago

Diffuse Scattering of X-Rays
by *B. E. Warren* and *B. L. Averbach*, Massachusetts Institute of Technology

Pole Figure Determinations
by *A. H. Geisler*, General Electric Co.

Techniques and Applications of Neutron Diffraction
by *C. G. Shull*, Oak Ridge National Laboratory

8:00 P.M.—Demonstration Lecture

BALLROOM, BENJAMIN FRANKLIN

Electron Emission Studies of Metallurgical Problems
by *Erwin W. Muller*, Pennsylvania State College

Sunday, Oct. 19

9:30 A.M.—Mechanical Methods

BALLROOM, BENJAMIN FRANKLIN

Deformation of Single Crystals
by *Earl R. Parker* and *Jack Washburn*, University of California

High-Speed Strain Measurements
by *George R. Irwin*, Naval Research Laboratory

Internal Friction
by *Charles A. Wert*, University of Illinois

2:00 P.M.—Ferromagnetic and Radioactive Methods

BALLROOM, BENJAMIN FRANKLIN

Ferromagnetic Domains
by *H. J. Williams*, Bell Telephone Laboratories

Radioactive Tracers
by *M. B. Bever*, Massachusetts Institute of Technology

Radioaction Damage as a Research Technique
by *Sidney Siegel*, North American Aviation, Inc.

Daily Technical Sessions

Monday, October 20, 1952

9:30 A.M.—Creep-Rupture and Recrystallization

BALLROOM, BENJAMIN FRANKLIN

Creep-Rupture and Recrystallization of Monel From 700 to 1700°F.
by *N. J. Grant* and *A. G. Bucklin*, Massachusetts Institute of Technology

Influence of Grain Size on High-Temperature Properties of Monel
by *Paul Shahinian* and *J. R. Lane*, Naval Research Laboratory

Creep and Rupture of Chromium-Nickel Austenitic Stainless Steels
by *E. J. Dulis*, *C. V. Smith* and *E. G. Houston*, United States Steel Co.

Recrystallization and Grain Growth in Alpha Brass
by *S. L. Channon*, Kaiser Aluminum and Chemical Corp. and *H. L. Walker*, University of Illinois

2:00 P.M.—High-Temperature Phases

BALLROOM, CONVENTION HALL

Microconstituents in High-Temperature Alloys
by *H. J. Beattie, Jr.*, and *F. L. VerSnyder*, General Electric Co.

Sigma Formation and Its Effect on the Impact Properties of Iron-Nickel-Chromium Alloys
by *A. M. Talbot* and *D. E. Furman*, International Nickel Co., Inc.

Mechanism of the Carburization of Some Stainless Steels
by *J. B. Giacobbe*, Superior Tube Co.

The Electrolytic Separation and Some Properties of Austenite and Sigma in 18-8-3-1 Chromium-Nickel-Molybdenum-Titanium Steel
by *T. P. Hoar*, University of Cambridge, England and *K. W. J. Bowen*, Imperial Chemical Industries

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Tuesday, Oct. 21

9:30 A.M.—Phase Transformation

BALLROOM, BENJAMIN FRANKLIN

The Effect of Composition on the Temperature of Spontaneous Transformation of Austenite to Martensite in 18-8 Type Stainless Steel
by *G. H. Eichelman*, American Brass Co. and *F. C. Hull*, Westinghouse Electric Corp.

The Effect of Silicon on the Tempering of Martensite
by *A. G. Allten* and *P. Payson*, Crucible Steel Co. of America

The Mechanism and Kinetics of the First Stage of Tempering
by *C. S. Roberts*, Dow Chemical Co.

The Order-Disorder Transformation Viewed as a Classical Phase Change
by *B. L. Averbach* and *M. Cohen*, Massachusetts Institute of Technology

by *F. N. Rhines* and *J. B. Newkirk*, Carnegie Institute of Technology

2:00 P.M.—Hardenability

BALLROOM, CONVENTION HALL

An End-Quench Test for Determining the Hardenability of Carburized Steels
by *F. X. Kayser*, *R. F. Thomson* and *A. L. Boegehold*, General Motors Corp.

The Influence of Boron on Case Hardenability in Alloy Carburizing Steels
by *C. F. Jatczak* and *E. S. Rowland*, Timken Roller Bearing Co.

Effect of Carbon Content on 18-4-1 High Speed Steel
by *A. H. Grobe* and *G. A. Roberts*, Vanadium-Alloys Steel Co.

Correlation of Machinability With Inclusion Characteristics in Resulphurized Bessemer Steels
by *L. H. VanVlack*, United States Steel Co.

Wednesday, Oct. 22

9:00 A.M.—Annual Meeting

BALLROOM, BENJAMIN FRANKLIN

Edward DeMille Campbell Memorial Lecture
by *Cyril Stanley Smith*, Institute for the Study of Metals

2:00 P.M.—Research

BALLROOM, CONVENTION HALL

A Study of the Mechanism of the Delayed Yield Phenomenon
by *T. Vreeland, Jr.*, *D. S. Wood* and *D. S. Clark*, California Institute of Technology

The Effect of Temperature on the Rolling Texture of Plastically Deformed Low-Carbon Steel Strip
by *Norman P. Goss*, Cold Metal Products Co.

Determination of Oxygen in Metals and Metal Oxides by the Isotopic Method
by *A. D. Kirshenbaum* and *A. V. Grosse*, Research Institute of Temple University

The Indium-Arsenic System
by *T. S Liu*, Horizons, Inc. and *E. A. Peretti*, University of Notre Dame

Thursday, Oct. 23

9:30 A.M.—Mechanical Properties

BALLROOM, CONVENTION HALL

The Effect of Quenching and Tempering on Residual Stresses in Manganese Oil Hardening Toolsteel
by *H. J. Snyder*, Mellon Institute of Industrial Research

X-Ray Measurement of Residual Stress in Hardened High-Carbon Steel
by *A. L. Christenson* and *E. S. Rowland*, Timken Roller Bearing Co.

The Endurance Limit of Temper Brittle Steel
by *R. D. Chapman* and *W. E. Jominy*, Chrysler Corp.

Plastic Stress-Strain Relations of Alcoa 14S-T6 for Variable Biaxial Stress Ratios
by *Joseph Marin*, *L. W. Hu* and *J. F. Hamburg*, Pennsylvania State College

2:00 P.M.—Temper Brittleness

BALLROOM, CONVENTION HALL

The Effect of Various Heat Treating Cycles Upon Temper Brittleness
by *L. D. Jaffe* and *D. C. Buffum*, Watertown Arsenal and *F. L. Carr*, National Research Corp.

Effect of Hardness on the Level of the Impact Energy Curve for Temper Brittle and Unembrittled Steel
by *F. L. Carr*, National Research Corp. *M. Goldman*, Battelle Memorial Institute *L. D. Jaffe* and *D. C. Buffum*, Watertown Arsenal

Transverse Mechanical Properties in an S.A.E. 1045 Forging Steel
by *A. H. Grobe*, Vanadium-Alloys Steel Co. *Cyril Wells* and *R. F. Mehl*, Carnegie Institute of Technology

The Determination of the Elastic Constants of Metals by the Ultrasonic Pulse Technique
by *M. B. Reynolds*, Knolls Atomic Power Laboratory, General Electric Co.

7:00 P.M.—Annual Dinner

BALLROOM, BENJAMIN FRANKLIN

Friday, Oct. 24

9:30 A.M.—Elevated-Temperature Properties

BALLROOM, CONVENTION HALL

Temperature Dependence of the Hardness of Pure Metals
by *J. W. Westbrook*, General Electric Co.

Hardness of Various Steels at Elevated Temperatures
by *F. Garofalo*, *P. R. Malenock* and *G. V. Smith*, United States Steel Co.

Some Properties of a Nodular Iron at Elevated Temperatures
by *M. S. Saunders* and *M. J. Sinnott*, University of Michigan

Accelerated Strain Aging of Commercial Sheet Steels
by *L. R. Shoenberger* and *E. J. Paliwoda*, Jones and Laughlin Steel Corp.

See Table of Contents, page 67, for abstracts of many of these technical papers

Three Lecture Courses

All Sessions in Ballroom, Convention Hall

Behavior of Metals at Low Temperatures

Monday, Oct. 20

4:30 P.M.—First Lecture

Behavior of Single Crystals and Pure Metals
by *R. M. Brick*, University of Pennsylvania

8:00 P.M.—Second and Third Lectures

Influence of Mechanical Variables
by *J. R. Low, Jr.*, Knolls Atomic Power Laboratory, General Electric Co.

Influence of Metallurgical Factors
by *C. H. Lorig*, Battelle Memorial Institute

Gases in Metals

Tuesday, Oct. 21—4:30 P. M.

Fundamental Metallurgical and Thermodynamic Principles of Gas-Metal Behavior
by *D. P. Smith*, Princeton University

Gases in Nonferrous Metals and Alloys
by *L. W. Eastwood*, Kaiser Aluminum Co.

Wednesday, Oct. 22—4:30 P. M.

The Behavior of Gases in Liquid Iron and Steel
by *D. J. Carney*, United States Steel Co.

The Behavior of Gases in Solid Iron and Steel
by *C. E. Sims*, Battelle Memorial Institute

Metallurgical Tools for Alloy Conservation and Increased Production

All Lectures by *J. Alfred Berger*, University of Pittsburgh

Tuesday, Oct. 21—8:00 P. M.

Significance of Chemical Analyses in Alloy Classification and Mechanical Properties

Progress in Spectrography and X-Ray Diffraction Analyses and Techniques

Wednesday, Oct. 22—8:00 P. M.

The Effects of Alloy Substitution on the Fundamentals of Hardening Metals

Boron and Rare Earths in Alloy Conservation and Production

American Welding Society Program

All Meetings at Bellevue-Stratford Hotel, Philadelphia

Monday, October 20, 1952

10:00 A.M.—Award of Prizes and Adams Lecture

ROSE GARDEN, BELLEVUE-STRATFORD

The Welding and Brazing of Titanium Alloys
by *C. B. Voldrich*, Battelle Memorial Institute

2:00 P.M.—Fabricating Procedures

ROSE GARDEN, BELLEVUE-STRATFORD

Fusion Welding Techniques for Jet Aircraft Components
by *Arnold S. Rose* and *Morton A. Braun*, I. T. E. Circuit Breaker Co.

Should Preheat Be Substituted for High-Temperature Stress Relief in the Codes?
by *E. Paul DeGarmo*, University of California

Chromium Recovery During Submerged-Arc Welding
by *James G. Kerr* and *David A. Elmer*, C. F. Braun & Co.

6:00 P.M.—President's Reception

BURGUNDY ROOM

2:00 P.M.—Resistance Welding

NORTH GARDEN, BELLEVUE-STRATFORD

Corrosion of Structural Spot Welds
by *B. Karnisky*, *E. P. Gruca* and *E. Kinelski*, Pullman-Standard Car Mfg. Co.

Maintenance of Resistance Welders in High-Speed Assembly Lines
by *James F. Salatin* and *O. D. Eichison*, Delco-Remy Div., General Motors Corp.

2:00 P.M.—Hard Facing and Flame Hardening

SOUTH GARDEN, BELLEVUE-STRATFORD

Hard Facing Alloys of the Chromium Carbide Type
by *H. S. Avery* and *H. J. Chapin*, American Brake Shoe Co.

Selection and Evaluation of Methods of Hard Facing
by *Jack J. Barry*, Air Reduction Sales Co.

Flame Hardening of Large-Diameter Thin-Wall Cylindrical Shells
by *G. S. Wing* and *G. A. Weber*, M. W. Kellogg Co.

Program of the American Welding Society (Continued)

Tuesday, Oct. 21

9:30 A.M.—Resistance Welding

NORTH GARDEN, BELLEVUE-STRATFORD

Calculation of Spot Weld Properties
by *Julius Heuschkel*, Westinghouse Electric Corp.

Temperature Distribution During Flash Welding of Steel—Part II
by *E. F. Nippes, W. F. Savage, J. J. McCarthy* and *S. S. Smith*, Rensselaer Polytechnic Institute

Spot Welding of Titanium Alloy Sheet
by *M. L. Begeman, Edwin H. Block, Jr.* and *Frank W. McBee, Jr.*, University of Texas

Spot Welding Magnesium With Three-Phase Low-Frequency Equipment
by *Dean L. Knight* and *Paul Thorne*, National Electric Welding Machines Co. and *Paul Klain*, Dow Chemical Co.

9:30 A.M.—Weldability

SOUTH GARDEN, BELLEVUE-STRATFORD

Further Studies of Crack Sensitivity of Aircraft Steels
by *A. W. Steinberger* and *J. Stoop*, Curtiss Wright Corp., Propeller Div.

Effect of Geometry on Stresses in Circular Patch Specimen
by *Alan V. Levy* and *Harry E. Kennedy*, University of California

Evaluation of the Circular Patch Weld Test
by *John E. Hockett* and *L. O. Seaborn*, University of California

Relationship of Welding Technique to Penetration and Dilution
by *Clarence E. Jackson* and *Arthur E. Shrubsall*, Union Carbide and Carbon Research Laboratories, Inc.

9:30 A.M.—Structural

ROSE GARDEN, BELLEVUE STRATFORD

The Behavior of Welded Portal Frames
by *E. R. Johnston* and *Lynn S. Beedle*, Lehigh University and *J. M. Ruzek*, C. F. Braun & Co.

Residual Stress and the Compressive Strength of Steel
by *Lynn S. Beedle* and *A. W. Huber*, Lehigh University and *Bruce G. Johnston*, University of Michigan

How to Save Cost by Designing for Structural Welding
by *Alfred E. Pearson*, Ingalls Iron Works Co.

Distortion Control in Structural Fabrication
by *Gordon Cape* and *Llewellyn Jehu*, Dominion Bridge Co., Ltd.

2:00 P.M.—Weldability

SOUTH GARDEN, BELLEVUE-STRATFORD

The Effect of Strain Rate on Twinning and Brittle Fracture in Low-Carbon Steel
by *D. Rosenthal* and *C. C. Woolsey, Jr.*, University of California

Interpretation of Test Data Regarding Brittle Strength and Transition Temperature of Structural Steel
by *N. M. Newmark* and *W. C. Hoeltje*, University of Illinois

Factors Affecting the Resistance of Pressure-Vessel Steels to Repeated Overloading
by *Robert D. Stout, John H. Gross* and *Schillings Tsang*, Lehigh University

2:00 P.M.—Resistance Welding

NORTH GARDEN, BELLEVUE-STRATFORD

Quality Control of Resistance Welding by Statistical Methods
by *J. F. Radford* and *R. K. Waldvogel*, Crosley Div., Avco Mfg. Corp.

Contact Resistance as Affected by Subdividing the Contact Area
by *Wm. B. Kouwenhoven* and *Clarence W. Little, Jr.*, Johns Hopkins University

New Multi-Spot Control Provides Increased Welding Production With Limited Power Supply
by *Claude R. Whitney, Jr.*, Square D Co.

2:00 P.M.—Brazing and Bronze Welding

ROSE GARDEN, BELLEVUE-STRATFORD

New Aspects in Surface Alloying in Brazing and Related Techniques
by *Robert Humphrey* and *Rene D. Wasserman*, Eutectic Welding Alloys Corp.

Strength Joints to Steel With Aluminum Bronze Filler Metals
by *Willis G. Groth*, Ampco Metal, Inc.

4:30 P.M.—Educational Lecture Series

ROSE GARDEN, BELLEVUE-STRATFORD

The Inert-Gas Metal-Arc Welding Process
by *Walter H. Wooding*, Philadelphia Naval Shipyard

6:30 P.M.—Section Officers Dinner and Meeting

JUNIOR ROOM, BELLEVUE-STRATFORD

Wednesday, Oct. 22

9:00 A.M.—Plant Visits

Optional Trips to Philadelphia Naval Shipyard, or Naval Air Material Center, or Steam Div., Westinghouse Electric Corp.

9:30 A.M.—Nonferrous

NORTH GARDEN, BELLEVUE-STRATFORD

The Semi-Automatic Inert-Gas Metal-Arc Welding of Aluminum Alloys
by *C. T. Gayley, J. R. Girini* and *W. H. Wooding*, Philadelphia Naval Shipyard

Welding 90-10 Cupronickel by the Inert-Gas Shielded-Arc Processes
by *L. H. Hawthorne*, Revere Copper and Brass, Inc.

Weld Cracking of Aluminum Alloys
by *James D. Dowd*, Aluminum Co. of America

9:30 A.M.—Weldability

ROSE GARDEN, BELLEVUE-STRATFORD

Relation of Preheating to Low-Temperature Cooling Rate Embrittlement and Microcracking
by *A. E. Flanigan* and *T. Micleu*, University of California

Initiation and Propagation of Brittle Fracture in Structural Steels
by *Peter P. Puzak, E. W. Eschbacher* and *W. S. Pellini*, Naval Research Laboratory

The Continuous Cooling Transformation of Weld Heat-Affected Zones
by *W. R. Apblett, Jr.*, *L. K. Poole* and *W. S. Pellini*, Naval Research Laboratory

The Determination of Optimum Conditions for the Automatic Welding of Hardenable Steels
by *C. R. McKinsey* and *J. F. Collins*, Union Carbide & Carbon Research Laboratories, Inc.

9:30 A.M.—Titanium Alloys

SOUTH GARDEN, BELLEVUE-STRATFORD

Practical Aspects of Arc Welding Titanium Alloys
by *J. J. Chyle* and *Ivan Kutuchief*, A. O. Smith Corp.

The Effects of Fe, Mn, Cr and Mo on Welds in Titanium
by *G. E. Faulkner*, *G. B. Grable* and *C. B. Voldrich*, Battelle Memorial Institute

An Investigation of the Thermal Cycles Adjacent to Arc Welds in ½-In. Titanium Plate
by *E. F. Nippes*, *J. M. Gerken* and *B. W. Schaaf*, Rensselaer Polytechnic Institute

Contaminants in Welding Titanium
by *R. W. Huber* and *Thomas R. Graham*, Bureau of Mines

2:00 P.M.—Weldability

NORTH GARDEN, BELLEVUE-STRATFORD

Embrittlement of High-Strength Ferritic Welds
by *Peter P. Puzak* and *William S. Pellini*, Naval Research Laboratory

Temper Brittleness in Low-Alloy Steel Weld Metal
by *Richard P. Wentworth* and *Hallock C. Campbell*, Arcos Corp.

The Effects of Electrodes and Welding Conditions on the Ductility of Arc Welded Mild Steels
by *Ernest F. Nippes* and *Alexander Lesnewich*, Rensselaer Polytechnic Institute

2:00 P.M.—Nonferrous

SOUTH GARDEN, BELLEVUE-STRATFORD

The Strength and Ductility of Welds in Aluminum Alloy Plate
by *F. M. Howell* and *F. G. Nelson, Jr.*, Aluminum Research Laboratories

Factors Which Determine the Performance of Aluminum Alloy Weldments
by *W. R. Apblett, Jr.*, *C. R. Felmley* and *W. S. Pellini*, Naval Research Laboratory

Welding and Forming of Titanium
by *Francis H. Stevenson*, Aerojet Engineering Corp.

2:00 P.M.—Maintenance and Gas Cutting

ROSE GARDEN, BELLEVUE-STRATFORD

Wear and Operation Problems in Maintenance
by *Frank J. Gaydos*, United States Steel Co.

Effect of Oxygen Cutting on Alloy Steel
by *F. C. Saacke*, Air Reduction Co., Inc.

4:30 P.M.—Educational Lecture Series

ROSE GARDEN, BELLEVUE-STRATFORD

The Inert-Gas Metal-Arc Welding Process
by *Walter H. Wooding*, Philadelphia Naval Shipyard

6:30 P.M.—National Officers Dinner and Meeting

PINK ROOM, BELLEVUE-STRATFORD

8:00 P.M.—W.R.C. University Research Conference

SOUTH GARDEN, BELLEVUE-STRATFORD

Thursday, Oct. 23

9:30 A.M.—Inert-Arc Welding

NORTH GARDEN, BELLEVUE-STRATFORD

A Comparison of Shielding Mixtures for Gas-Shielded Arc Welding
by *John W. Cunningham*, Air Reduction Co., Inc.

Production Welding of Mild and Low-Alloy Steels by Gas-Shielded Arc Welding
by *John H. Berryman*, Air Reduction Co., Inc.

Porosity in Mild Steel Weld Metal
by *Donald Warren*, E. I. du Pont de Nemours & Co., Inc. and *R. D. Stout*, Lehigh University

9:30 A.M.—Brazing

SOUTH GARDEN, BELLEVUE-STRATFORD

Advanced Information for the Brazing Operator
by *E. F. Davis*, Westinghouse Electric Corp.

Joint Design for Brazing
by *W. J. Van Natten*, General Electric Co.

Technical Aspects of Soldering Practices
by *R. M. MacIntosh*, Tin Research Institute, Inc.

Production Brazing
by *J. R. Wirt*, Delco-Remy Div., General Motors Corp.

9:30 A.M.—Marine Construction

ROSE GARDEN, BELLEVUE-STRATFORD

New Rules for Welding Low-Alloy Ferritic Pipe Material
by *Commander Charles F. Perry, U. S. C. G.*

Evaluation of Brittle Failure Research
by *Paul Ffield* and *Ed Sweeney*, Bethlehem Steel Co.

An Investigation on Peening
by *P. L. Calamari*, *F. J. Crum* and *G. W. Place*, American Bureau of Shipping

2:00 P.M.—Business Meeting

CLOVER ROOM, BELLEVUE-STRATFORD

7:00 P.M.—Annual Dinner

BALLROOM, BELLEVUE-STRATFORD

Friday, Oct. 24

9:30 A.M.—Pipe

NORTH GARDEN, BELLEVUE-STRATFORD

Pipe Welding in the Petroleum Refining Industry
by *Albert W. Zeuthen*, Socony Vacuum Oil Co.

The Arc Welding of Low Chromium-Molybdenum Steel Pipe
by *J. Bland*, *L. J. Privoznik* and *F. J. Winsor*, Standard Oil Co. of Indiana

Effect of Stresses and Stress Relief on the Bursting Strength of Circumferentially Welded Pipe
by *L. J. Privoznik* and *F. J. Winsor*, Standard Oil Co. of Indiana

Program of the American Welding Society (Continued)

9:30 A.M.—Inert Arc

SOUTH GARDEN, BELLEVUE-STRATFORD

Inert-Gas Shielding of the Metallic Arc
by *William L. Green* and *Robert J. Krieger*, Ohio State University

Gas Flow Requirements for Inert-Gas Arc Shielding
by *Glenn J. Gibson*, Air Reduction Co., Inc.

Shielded-Arc Welding of Jet-Engine Components
by *K. H. Koopman*, Linde Air Products Co.

9:30 A.M.—Marine Construction

ROSE GARDEN, BELLEVUE-STRATFORD

Prevention of Marine Corrosion by Metallizing Systems
by *Howard Vanderpool*, Metallizing Engineering Co.

Observations on Experience With Welded Ships
by *David P. Brown*, American Bureau of Shipping

Failure and Defects Encountered in Welded Ship Construction
by *Ralph D. Braduay*, New York Shipbuilding Corp.

Institute of Metals Division

American Institute of Mining and Metallurgical Engineers

All Meetings at Adelphia Hotel, Philadelphia

Sunday, Oct. 19

8:00 P.M.—I.M.D. Program Committee Meeting

JUNIOR ROOM, ADELPHIA

Monday, Oct. 20

9:00 A.M.—Thermodynamic and Thermal Properties

CRYSTAL ROOM, ADELPHIA

Scaling of Lead in Air
by *Elmer Weber*, Chase Brass and Copper Co.
and *W. M. Balducin, Jr.*, Case Institute of Technology

Concentration Dependence of Diffusion Coefficients in Metallic Solid Solutions
by *D. E. Thomas*, Westinghouse Atomic Power Div.
and *C. E. Birchenall*, Carnegie Institute of Technology

Thermodynamic Properties of Solid Nickel-Gold Alloys
by *L. L. Seigle*, Sylvania Electric Products Inc.
M. Cohen and *B. L. Averbach*, Massachusetts Institute of Technology

Transformation in Cobalt-Nickel Alloys
by *J. B. Hess*, Kaiser Aluminum and Chemical Corp.
and *C. S. Barrett*, University of Chicago

Principles of Zone-Melting
by *W. G. Pfann*, Bell Telephone Laboratories

Segregation of Two Solutes, With Particular Reference to Semiconductors
by *W. G. Pfann*, Bell Telephone Laboratories

9:00 A.M.—High Temperature

JEFFERSON ROOM, ADELPHIA

Some Observations of Sub-Grain Formation During Creep in High-Purity Aluminum
by *I. S. Servi*, Union Carbide & Carbon Corp.
J. T. Norton and *N. J. Grant*, Massachusetts Institute of Technology

Observations of Creep of the Grain Boundary in High-Purity Aluminum
by *H. C. Chang* and *N. J. Grant*, Massachusetts Institute of Technology

Creep Correlations in Alpha Solid Solutions of Aluminum
by *O. D. Sherby* and *J. E. Dorn*, University of California

Effect of Zirconium on Magnesium-Thorium and Magnesium-Thorium-Cerium Alloys
by *T. E. Leontis*, Dow Chemical Co.

Influence of Chemical Composition on the Rupture Properties at 1200° F. of Wrought Cr-Ni-Co-Fe-Mo-W-Cb Alloys
by *E. E. Reynolds*, Allegheny Ludlum Steel Corp.
J. W. Freeman and *A. E. White*, University of Michigan

High-Temperature Oxidation of Some Iron-Chromium Alloys
by *D. Caplan* and *M. Cohen*, National Research Council, Ottawa

Mechanical Properties of Intermetallic Compounds at Elevated Temperatures
by *Robert Lowrie*, Lewis Flight Propulsion Laboratory

2:00 P.M.—Research in Progress

CRYSTAL ROOM, ADELPHIA

4:30 P.M.—I.M.D. Membership Committee Meeting

JUNIOR ROOM, ADELPHIA

6:30 P.M.—I.M.D. Executive Committee Dinner Meeting

CORAL ROOM, ADELPHIA

Tuesday, Oct. 21

9:00 A.M.—Symposium on Titanium and Titanium Alloys

CRYSTAL ROOM, ADELPHIA

Early History of Titanium
by *M. A. Hunter*, Rensselaer Polytechnic Institute

Developments Leading to Present Technology
by *F. J. Cservenyak*, U. S. Bureau of Mines

Significance of Titanium in Airframe Construction
by *Col. J. S. Dick*, Air Force Materiel Command

Titanium as an Ordnance Material
by *Col B. S. Mesick*, Ordnance Corps, Watertown Arsenal

Titanium as a Naval Material
by *E. L. Beardman*, Office of Naval Materials

New Processes for Reduction of Titanium
by *R. S. Dean*, Consulting Engineer

Dimensional Fabrication of Titanium Without Melting
by *G. S. Daries*, Brush Development Co.

9:00 A.M.—Deformation

JEFFERSON ROOM, ADELPHIA

Dynamic Formation of Slip Bands in Aluminum
by *N. K. Chen* and *R. B. Pond*, Johns Hopkins University

Observations on the Tension Texture of Aluminum
by *E. A. Calnan* and *Betty E. Williams*, National Physical Laboratory

Deformation of Zinc Bicrystals by Thermal Ratcheting
by *J. E. Burke* and *Anna M. Turkalo*, General Electric Co.

Surface Effects in the Slip and Twinning of Metal Monocrystals
by *J. J. Gilman* and *T. A. Read*, Columbia University

Kinking in Zinc Single Crystal Tension Specimens
by *Jack Washburn* and *E. R. Parker*, University of California

2:00 P.M.—Symposium on Titanium and Titanium Alloys (Cont'd.)

CRYSTAL ROOM, ADELPHIA

Currently Available Alloys, Forgings and Bars
by *L. R. Frazier*, General Electric Co.

Sheet and Strip
Speaker to be announced

Recent Metallurgical Developments
by *Thomas Lippert*, Titanium Metals Corp. of America
W. L. Finlay, Rem-Cru Titanium, Inc.
F. H. Vandenburgh, Mallory Sharon Titanium Corp.
B. H. Whitmer, Republic Steel Corp.
and *E. H. Gee*, E. I. du Pont de Nemours & Co., Inc.

2:00 P.M.—Physical Metallurgy

JEFFERSON ROOM, ADELPHIA

Development of Mechanical and Magnetic Hardness in a 10% Vanadium-Cobalt-Iron Alloy
by *R. W. Fountain*, Union Carbide and Carbon Corp.
and *J. F. Libsch*, Lehigh University

Observations on Nodular Graphite
by *H. M. Weld*, *R. L. Cunningham* and *F. W. C. Boswell*, Department of Mines and Technical Surveys

Strain Patterns in Charpy Impact Specimens of 0.20% Carbon Mild Steel
by *R. S. Bumps*, Studebaker Corp.

Recrystallization Kinetics of Low-Carbon Steel
by *S. F. Reiter*, General Electric Co.

Effect of Molybdenum and of Nickel on the Rate of Nucleation and the Rate of Growth of Pearlite
by *R. W. Parcel*, Rem-Cru Titanium, Inc.
and *R. F. Mehl*, Carnegie Institute of Technology

Effect of Applied Stress on the Martensitic Transformation
by *S. A. Kulin*, Westinghouse Atomic Power Div.
M. Cohen and *B. L. Averbach*, Massachusetts Institute of Technology

A Study of Grain Shape in an Aluminum Alloy and Other Applications of Stereoscopic Microradiography
by *W. M. Williams*, Revere Copper and Brass Co.
and *C. S. Smith*, University of Chicago

7:00 P.M.—Institute of Metals Dinner

CRYSTAL ROOM, ADELPHIA

Wednesday, Oct. 22

12:15 P.M.—I.M.D. Powder Metallurgy Committee Luncheon

CORAL ROOM, ADELPHIA

2:00 P.M.—Titanium

CRYSTAL ROOM, ADELPHIA

Titanium-Chromium Phase Diagram
by *F. B. Cuff*, *N. J. Grant* and *C. F. Floe*, Massachusetts Institute of Technology

Titanium-Copper Binary Phase Diagram
by *A. Joukainen*, E. I. du Pont de Nemours & Co., Inc.
N. J. Grant and *C. F. Floe*, Massachusetts Institute of Technology

Titanium-Aluminum System
by *E. S. Bumps*, *H. D. Kessler* and *M. Hansen*, Armour Research Foundation

Observations on the Lattice Parameters of the Alpha and TiO Phases in the Titanium-Oxygen System
by *W. Rostoker*, Armour Research Foundation

Nature of the Line Markings in Titanium and Alpha Titanium Alloys
by *C. M. Craighead*, *G. A. Lenning* and *R. I. Jaffee*, Battelle Memorial Institute

Time-Temperature-Transformation Characteristics of Titanium-Molybdenum Alloys
by *D. J. DeLazaro*, *M. Hansen*, *R. E. Riley* and *W. Rostoker*, Armour Research Foundation

Compression Texture of Iodide Titanium
by *D. N. Williams* and *D. S. Eppelsheimer*, Missouri School of Mines and Metallurgy

Partial Titanium-Vanadium Phase Diagram
by *Paul Pietrokowsky* and *Pol Duwez*, California Institute of Technology

2:00 P.M.—Constitution Diagrams

JEFFERSON ROOM, ADELPHIA

Tungsten-Cobalt-Carbon System
by *Pekka Rautala* and *J. T. Norton*, Massachusetts Institute of Technology

Role of the Binder Phase in Cemented WC-Co Alloys
by *Joseph Gurland*, Firth Sterling Steel & Carbide Corp. and *J. T. Norton*, Massachusetts Institute of Technology

Solubility of Carbon and Oxygen in Molybdenum
by *W. E. Few* and *G. K. Manning*, Battelle Memorial Institute

A Thermal and Dilatometric Investigation of the Alloys of Cobalt With Chromium and Molybdenum
by *A. G. Metcalfe*, Deloro Smelting and Refining Co.

System Molybdenum-Boron and Some Properties of the Molybdenum Borides
by *Robert Steinitz*, *Ira Binder* and *David Moskowitz*, American Electro Metal Corp.

Systems Zr-Mo and Zr-W
by *R. F. Domagala*, *D. J. McPherson* and *M. Hansen*, Armour Research Foundation

Copper-Zinc Constitution Diagram Redetermined in the Vicinity of the Beta Phase
by *Lilian Beck* and *C. S. Smith*, University of Chicago

Intermediate Phases in the Mo-Fe-Co, Mo-Fe-Ni, and Mo-Ni-Co Ternary Systems
by *D. K. Das*, Notre Dame University
S. P. Rideout, E. I. du Pont de Nemours Argonne National Lab. and *P. A. Beck*, University of Illinois

Society for Non-Destructive Testing

All Meetings at Sylvania Hotel, Philadelphia

Monday, Oct. 20

9:30 A.M.—Welcoming Addresses

10:00 A.M.—Lowering Production Costs With Modern X-Ray Equipment

The General Electric Industrial Betatron
by *T. W. Dietze*, General Electric Co.

Modern Techniques in Precision High-Voltage Radiography
by *E. Alfred Burrill*, High-Voltage Engineering Corp.

Uses of Low-Voltage X-Ray Tubes With Thin Beryllium Windows in Nondestructive Testing
by *Tom H. Rogers*, Machlett Laboratories

The Current Status of the Picker-Polaroid Process for One-Minute Radiography in the Industrial Field
by *W. B. Pyle*, Picker X-Ray Corp.

**Alternate:* Direct-Exposure Enlargement Techniques in Radiography and Fluoroscopy Utilizing Fractional-Focus X-Ray Tubes
by *Leo C. Katraschek*, North American Philips Co., Inc.

2:00 P.M.—New Techniques for Applying X-Ray Nondestructive Tests

Reduction of Exposure Time in Gamma Radiography
by *J. J. Hirschfield* and *D. T. O'Connor*, Naval Ordnance Laboratory

Techniques Used in Measuring Uniformity of Materials by Means of Gamma Radiation
by *Laurence R. Megill* and *John N. Harris*, Los Alamos Scientific Laboratories

Some Industrial Applications of Microradiography
by *S. Goldspiel* and *F. Bernstein*, New York Naval Shipyard

Gaging Tin Coatings in the Steel Industry by X-Ray Fluorescence Analysis
by *Frederick A. Behr*, North American Philips Co., Inc.

Alternate: Application of Fluorescence X-Rays to Metallurgical Microradiography
by *Herman E. Seeman* and *H. R. Splettstosser*, Eastman Kodak Co.

Alternate: Iridium^{192} in Industrial Radiography
by *James V. Rigbey* and *C. F. Baxter*, Ford Motor Co. of Canada

Tuesday, Oct. 21

9:00 A.M.—Control and Interpretation in X-Ray Nondestructive Testing

Film Characteristics as Applied to Radiation Monitoring
by *George Corney*, Eastman Kodak Co.

Problems of Mechanical Film Development
by *Donald F. Hauptman* and *Gerold H. Tenney*, Los Alamos

Various Penetrameter Types and Their Limitations
by *Norman C. Miller* and *Gerold H. Tenney*, Los Alamos

Interpretation of Radiographs of Aluminum and Magnesium Castings
by *J. J. Pierce*, Naval Ordnance Laboratory

Alternate: Semi-Empirical Equation for the Spectral Energy Distribution in X-Ray Beams
by *Charles R. Emigh*, Los Alamos

2:00 P.M.—The Economics of Nondestructive Testing to Lower Production Costs

Economic Factors in Nondestructive Testing
by *W. E. Thomas*, Magnaflux Corp.

Quality Control Application of Nondestructive Tests in the Airframe Industries Which Will Effectively Lower Production Costs
by *B. W. Clauson*, Douglas Aircraft, Inc.

The Use of Nondestructive Test Methods in Heavy Manufacture
by *James A. Prau*, Westinghouse Electric Corp.

Alternate: Bibliography of Nondestructive Testing
Speaker to be announced

5:00 P.M. and 9:00 P.M.—Annual Officers' Reception and Social Meeting

*_Alternate_ papers are to be read by title only.

Wednesday, Oct. 22

9:00 A.M.—New Methods and Applications of Ultrasonic Nondestructive Tests

Ultrasonic Absorption, Its Relation to Test Interpretation, and Its Correlation With Service Performance
by *Leslie W. Ball*, U. S. Naval Test Station

Electronic Reproduction of Ultrasonic Immersion Images
by *Donald Erdman*, Electro Circuits, Inc.

Ultrasonic Examinations of Weldments and the Establishment of Safe Acceptable Limits for Defects
by *Frank C. Parker*, Carbide and Carbon Chemicals Co.

Ultrasonic Equipment for High-Precision Thickness Measurements
by *Peter K. Bloch*, Branson Instrument Co.

Ultrasonic Testing of Cast Iron Pipe
by *G. B. Baumeister*, Magnaflux Corp.

Alternate: Geophysics—Its Relation to Nondestructive Testing
by *Peter Dehlinger* and *Sam Wenk*, Battelle Memorial Institute

Alternate: Economic Industrial Applications of the Metroscope
by *Mr. Mann*, Walter Kiddie and Co.

Alternate: Future Trends in Industrial Ultrasonic Testing
by *William I. Bendz*, Sperry Products, Inc.

2:00 P.M.—New Electromagnetic Nondestructive Tests to Lower Production Costs

Industrial Evaluation of Search Coil Flaw Detection Techniques
by *Carleton E. Hastings*, Watertown Arsenal

A Metals Comparator for the Inspection and Classification of Metals
by *B. M. Smith*, General Electric Co.

Industrial Applications of Eddy-Current Testing
by *W. A. Cannon*, Magnaflux Corp.

Alternate: New Nondestructive Test Instruments Developed by the Institut Dr. Foerster
by *Friedrich Foerster*, Institut Dr. Foerster, Germany

Thursday, Oct. 23

9:00 A.M.—Using Liquid-Penetrant and Electrical Nondestructive Test Methods to Lower Industrial Production Costs

Comparison of Materials for Liquid Penetrant Inspection
by *Hamilton Migel* and *Taber de Forest*, Magnaflux Corp.

Lowering Production Costs With Turco Dy-Chek and Turco Chek-Spek
by *Gordon Rice*, Turco Products, Inc.

The Application of Wire-Resistance Strain Gages to Lower Production Costs
by *Francis G. Tatnall*, Baldwin-Lima-Hamilton Corp.

Filtered Particle Inspection of High-Tension Insulators
by *Henry N. Staats*, Magnaflux Corp.

Alternate: The Measurement of Ionization in Dielectric Structures—a New Nondestructive Test for Electrical Insulating Materials
by *D. A. Lupfer*, General Electric Co.

2:00 P.M.—Mehl Honor Lecture

Industrial Fluoroscopy
by *Donald T. O'Connor*, Naval Ordnance Laboratory

3:00 P.M.—Annual Business Meeting

Special Libraries Association, Metals Section

Monday, Oct. 20

2:00 P.M.—New Horizons in Literature Searching

FRANKLIN ROOM, BENJAMIN FRANKLIN HOTEL

International Cooperation in Metallurgical Literature Classification; Report of Interim Committee
by *Marjorie R. Hyslop*, American Society for Metals

Operation of a Technical Information Center
by *R. C. McMaster* and *Iver Igelsrud*, Battelle Memorial Institute

Application of Standard Business Machine Punched-Card Equipment to Metallurgical Literature References
by *Alvin T. Maierson* and *W. W. Howell*, Battelle Memorial Institute

The I.B.M. Electronic Information Searching System
by *H. P. Luhn*, International Business Machines Corp.

Use of the Univac System in Library Reference
by *Herbert F. Mitchell, Jr.*, Remington Rand, Inc.

A Marginal Punched-Card System for a Specialized Information Collection
by *Milton W. Sebring*, Norton Co.

Specialized Machines of the Future for Handling Broad Ranges of Subject Matter
by *James W. Perry*, Massachusetts Institute of Technology

Tuesday, Oct. 21

9:00 A.M.—Technical Session

ENGINEERS CLUB

Research Reports, Their Organization and Availability
by *I. A. Warheit*, Argonne National Laboratory

How to Obtain Unclassified Material From the Government
by *Eugene B. Jackson*, National Advisory Committee for Aeronautics

Foreign Language Literature and the New International Journal
by *John H. Hollomon*, General Electric Co.

2:00 P.M.—Technical Session

BETSY ROSS ROOM A, BENJAMIN FRANKLIN HOTEL

Foreign Language Literature in Translation
by *Frederica M. Weitlauf*, Timken Roller Bearing Co.

Technical Research Vs. the Librarian
by *Iver Igelsrud*, Battelle Memorial Institute

Selling Your Library to Management
by *M. H. Bigelow*, Plaskon Co., Inc.

CONSOLIDATED PROGRAM

34th National Metal Congress

AMERICAN SOCIETY FOR METALS

INSTITUTE OF METALS DIVISION,
AMERICAN INSTITUTE OF MINING & METALLURGICAL ENGINEERS (A.I.M.E.)

AMERICAN WELDING SOCIETY (A.W.S.)

SOCIETY FOR NON-DESTRUCTIVE TESTING (S.N.T.)

METALS SECTION, SPECIAL LIBRARIES ASSOCIATION (S.L.A.)

Saturday, October 18, 1952

9:30 A.M., 2:00 P.M. and 8:00 P.M. Seminar: Research Techniques; Ballroom, Benjamin Franklin Hotel

Sunday, October 19, 1952

9:30 A.M. and 2:00 P.M. Seminar: Research Techniques; Ballroom, Benjamin Franklin Hotel

8:00 P.M. A.I.M.E. Program Committee; Junior Room, Adelphia Hotel

Monday, October 20, 1952

9:00 A.M. A.I.M.E. Thermodynamics and Thermal Properties; Crystal Room, Adelphia Hotel

9:00 A.M. A.I.M.E. High Temperature; Jefferson Room, Adelphia Hotel

9:30 A.M. Creep-Rupture and Recrystallization; Ballroom, Benjamin Franklin Hotel

9:30 A.M. S.N.T. Welcome to Annual Meeting; Sylvania Hotel

10:00 A.M. S.N.T. Lowering Production Costs With Modern X-Ray Equipment; Sylvania Hotel

10:00 A.M. A.W.S. Award of Prizes; Rose Garden, Bellevue-Stratford Hotel

10:30 A.M. A.W.S. Adams Lecture; Rose Garden, Bellevue-Stratford Hotel

12:00 M. Opening of National Metal Exposition; Convention Hall

2:00 P.M. High-Temperature Phases; Ballroom, Convention Hall

2:00 P.M. A.W.S. Fabricating Procedures: Rose Garden, Bellevue-Stratford Hotel

2:00 P.M. A.W.S. Resistance Welding; North Garden, Bellevue-Stratford Hotel

2:00 P.M. A.W.S. Hard Facing and Flame Hardening; South Garden, Bellevue-Stratford Hotel

2:00 P.M. A.I.M.E. Research in Progress; Crystal Room, Adelphia Hotel

2:00 P.M. S.N.T. New Techniques for Applying X-Ray Nondestructive Tests; Sylvania Hotel

2:00 P.M. S.L.A. New Horizons in Literature Searching; Franklin Room, Benjamin Franklin Hotel

4:30 P.M. First Lecture: Behavior of Metals at Low Temperatures; Ballroom, Convention Hall

4:30 P.M. A.I.M.E. Membership Committee: Junior Room, Adelphia Hotel

6:00 P.M. A.W.S. President's Reception: Burgundy Room, Bellevue-Stratford Hotel

Monday's Program, Continued

6:30 P.M. A.I.M.E. Executive Committee; Dinner: Coral Room, Adelphia Hotel

8:00 P.M. Second Lecture: Behavior of Metals at Low Temperatures; Ballroom, Convention Hall

10:30 P.M. National Metal Exposition closes

Tuesday, October 21, 1952

9:00 A.M. A.I.M.E. Symposium on Titanium and Titanium Alloys; Crystal Room, Adelphia Hotel

9:00 A.M. A.I.M.E. Deformation; Jefferson Room, Adelphia Hotel

9:00 A.M. S.L.A. Technical Session; Engineers Club

9:00 A.M. S.N.T. Control and Interpretation in X-Ray Nondestructive Testing; Sylvania Hotel

9:30 A.M. Phase Transformation; Ballroom, Benjamin Franklin Hotel

9:30 A.M. A.W.S. Resistance Welding; North Garden, Bellevue-Stratford Hotel

9:30 A.M. A.W.S. Weldability; South Garden, Bellevue-Stratford Hotel

9:30 A.M. A.W.S. Structural; Rose Garden, Bellevue-Stratford Hotel

11:30 A.M. Canadian Fellowship Hour and Luncheon; Betsy Ross Room, Benjamin Franklin Hotel

12:00 M. Battelle Alumni Luncheon; Franklin Room, Benjamin Franklin Hotel

12:00 M. National Metal Exposition opens; Convention Hall

2:00 P.M. Hardenability; Ballroom, Convention Hall

2:00 P.M. A.W.S. Weldability; South Garden, Bellevue-Stratford Hotel

2:00 P.M. A.W.S. Resistance Welding; North Garden, Bellevue-Stratford Hotel

2:00 P.M. A.W.S. Brazing and Bronze Welding; Rose Garden, Bellevue-Stratford Hotel

2:00 P.M. A.I.M.E. Symposium on Titanium and Titanium Alloys; Crystal Room, Adelphia Hotel

2:00 P.M. A.I.M.E. Physical Metallurgy; Jefferson Room, Adelphia Hotel

2:00 P.M. S.N.T. Economics of Nondestructive Testing to Lower Production Costs; Sylvania Hotel

2:00 P.M. S.L.A. Technical Session; Betsy Ross Room A, Benjamin Franklin Hotel

4:30 P.M. First Lecture Session: Gases in Metals; Ballroom, Convention Hall

Tuesday's Program, Continued

4:30 P.M. A.W.S. First Lecture: Inert-Gas Metal-Arc Welding Process; Rose Garden, Bellevue-Stratford
4:30 P.M. A.I.M.E. Publications Committee; Junior Room, Adelphia Hotel
5:00 P.M. S.N.T. Social Meeting; Sylvania Hotel
6:30 P.M. A.W.S. Section Officers Dinner; Junior Room, Bellevue-Stratford Hotel
7:00 P.M. A.I.M.E. Annual Dinner; Crystal Room, Adelphia Hotel
8:00 P.M. ⊖ First Lecture Session: Metallurgical Tools for Alloy Conservation; Ballroom, Convention Hall
9:00 P.M. S.N.T. Social Meeting; Sylvania Hotel
10:30 P.M. National Metal Exposition closes

Wednesday, October 22, 1952

8:00 A.M. ⊖ Chapter Chairmen's Breakfast; Benjamin Franklin Hotel
8:30 A.M. Industrial Gas Breakfast; Penn-Sheraton Hotel
9:00 A.M. ⊖ Annual Meeting; Ballroom, Benjamin Franklin Hotel
9:00 A.M. S.N.T. New Methods and Applications of Ultrasonic Nondestructive Tests; Sylvania Hotel
9:30 A.M. A.W.S. Nonferrous; North Garden, Bellevue-Stratford Hotel
9:30 A.M. A.W.S. Weldability; Rose Garden, Bellevue-Stratford Hotel
9:30 A.M. A.W.S. Titanium Alloys; South Garden, Bellevue-Stratford Hotel
10:30 A.M. ⊖ Campbell Memorial Lecture; Ballroom, Benjamin Franklin Hotel
12:00 M. Alumni Luncheons; Benjamin Franklin Hotel
12:00 M. National Metal Exposition opens; Convention Hall
12:15 P.M. A.I.M.E. Powder Metallurgy Committee Luncheon; Coral Room, Adelphia Hotel
2:00 P.M. ⊖ Research; Ballroom, Convention Hall
2:00 P.M. A.W.S. Weldability; North Garden, Bellevue-Stratford Hotel
2:00 P.M. A.W.S. Nonferrous; South Garden, Bellevue-Stratford Hotel
2:00 P.M. A.W.S. Maintenance and Gas Cutting; Rose Garden, Bellevue-Stratford Hotel
2:00 P.M. A.I.M.E. Titanium; Crystal Room, Adelphia
2:00 P.M. A.I.M.E. Constitution Diagrams; Jefferson Room, Adelphia Hotel
2:00 P.M. S.N.T. New Electromagnetic Nondestructive Tests; Sylvania Hotel

Wednesday's Program, Continued

4:30 P.M. ⊖ Second Lecture Session: Gases in Metals; Ballroom, Convention Hall
4:30 P.M. A.W.S. Second Lecture: Inert-Gas Metal-Arc Welding Process; Rose Garden, Bellevue-Stratford
6:30 P.M. A.W.S. National Officers Dinner; Pink Room, Bellevue-Stratford Hotel
8:00 P.M. A.W.S. W.R.C. University Research Conference; South Garden, Bellevue-Stratford Hotel
8:00 P.M. ⊖ Second Lecture Session: Alloy Conservation; Ballroom, Convention Hall
10:30 P.M. National Metal Exposition closes

Thursday, October 23, 1952

9:00 A.M. S.N.T. Liquid-Penetrant and Electrical Nondestructive Test Methods; Sylvania Hotel
9:30 A.M. ⊖ Mechanical Properties; Ballroom, Convention Hall
9:30 A.M. A.W.S. Inert-Arc Welding; North Garden, Bellevue-Stratford Hotel
9:30 A.M. A.W.S. Brazing; South Garden, Bellevue-Stratford Hotel
9:30 A.M. A.W.S. Marine Construction; Rose Garden, Bellevue-Stratford Hotel
10:00 A.M. National Metal Exposition opens
2:00 P.M. ⊖ Temper Brittleness; Ballroom, Convention Hall
2:00 P.M. A.W.S. Business Meeting; Clover Room, Bellevue-Stratford Hotel
2:00 P.M. S.N.T. Mehl Honor Lecture; Sylvania Hotel
3:00 P.M. S.N.T. Business Meeting; Sylvania Hotel
3:00 P.M. A.W.S. Board of Directors Meeting; Junior Room, Bellevue-Stratford Hotel
6:00 P.M. National Metal Exposition closes
7:00 P.M. ⊖ Annual Dinner; Ballroom, Benjamin Franklin Hotel
7:00 P.M. A.W.S. Annual Dinner; Ballroom, Bellevue-Stratford Hotel

Friday, October 24, 1952

9:30 A.M. ⊖ Elevated-Temperature Properties; Ballroom, Convention Hall
9:30 A.M. A.W.S. Pipe; North Room, Bellevue-Stratford Hotel
9:30 A.M. A.W.S. Inert Arc; South Garden, Bellevue-Stratford Hotel
9:30 A.M. A.W.S. Marine Construction; Rose Garden, Bellevue-Stratford Hotel

Registration Charges for Technical Sessions

American Institute of Mining and Metallurgical Engineers
Members—$2.00
Nonmembers—$4.00
Student members—No charge
Student nonmembers—$1.00

Society for Non-Destructive Testing
Members—No charge
Nonmembers—$3.00

American Welding Society
Members—$1.00
Nonmembers—$2.00

American Society for Metals
Members and guests—No charge

Metals Section Special Libraries Association
Members and guests—No charge

Producers of Metals and Alloys

IN THIS classification of "What to See and Where to See It" at the National Metal Congress and Exposition (which will occupy the next 20 pages) it is only natural to start with the primary metals. It is also only proper to give first mention to the Philadelphia region itself as a steelmaking center. It has a long and honorable history. Within its boundaries may be found The Midvale Co., America's pioneer manufacturer of alloy steels for structural uses. The radius need not be extended 30 miles to include Henry Disston & Sons at Tacony, makers of electric furnace toolsteels; Alan Wood Steel Co. at Conshohocken, manufacturers of sheet and plate; and John A. Roebling's Sons Co., leading American proponent of acid openhearth steel for quality wire and wire rope. Under construction near Morrisville is the enormous Fairless Works of U. S. Steel Co. In the Exposition, Philadelphia Electric Co. will concentrate on promoting this region as a reborn metallurgical center, where raw materials, labor, transportation facilities are happily combined.

Stainless Steels will be featured by Allegheny Ludlum Steel Corp. and The Carpenter Steel Co., along with other alloy and toolsteels. Allegheny Ludlum has been promoting stainless for structures ever since 18-8 was so successfully used for exterior trim of the Chrysler and Empire State buildings in New York City. In the intervening 25 years a few other notable buildings have used stainless on their exteriors, but the climax has been reached in the new Gateway Center at Pittsburgh where shop-fabricated "curtain walls" form the entire outside of skyscrapers (other than window openings). Curtain walls are made of 22-gage stainless, Type 430 or 302, backed with 1½-in. insulation and 3 in. of reinforced concrete — as strong and rigid as a 13-in. masonry wall, lighter, more easily erected, and practically indestructible. Allegheny Ludlum believes in "taking its own medicine" and has used similar construction for its new research laboratory in Brackenridge.

The Carpenter Steel Co. will highlight the results of three major lines of research. One is "Carpenter 10", a low-carbon, austenitic chromium-nickel composition, narrowly adjusted so it work hardens at an unusually slow rate and is therefore attractive for bolts and other products which are severely upset during manufacture. Another is "Carpenter 20", the 20-30 Cr-Ni alloy with 3% Cu and 2% Mo (described in "Critical Points", *Metal Progress*, February 1948), highly resistant to impure, hot sulphuric acid. Finally there are the most recent additions of cerium and related rare-earth metals to refractory high alloys which give them much more ductility and forgeability; one important application would be to forged blades for gas turbines.

The real high-temperature materials will be exemplified by Kennametal Inc.'s "Kentanium", titanium carbide bonded with nickel. Since this was described at length in last April's *Metal Progress*, the reader may remember that it has already been put to use by progressive metals engineers.

Precious Metals are akin to stainless — or *vice versa*. Baker & Co., Inc., pioneering American refiners and workers of platinum, will feature conventional laboratory ware and spinnerettes for synthetic fibers, as well as thermostatic bimetals, rupture disks, and electrical contacts using other precious metals. Laminated and solid precious metals for industrial use will also be exhibited by D. E. Makepeace Co. — composite bars or strip of base metal (usually copper alloys) and a precious metal (usually silver). The precious metal may be on either edge or through the center; round or square tubing may be lined outside or inside. Makepeace also brazes precious metal slugs into strip stock, accurately positioned to order, so small parts can be blanked or formed.

American Nickeloid Co. will exhibit strip and sheet of steel, copper, brass, zinc or aluminum, one or both sides of which are electroplated with nickel, chromium, brass or copper. Also available are crimped, corrugated or striped sheets, electroplated, variously finished and protected from damage during fabrication in customers' shops by gummed paper or plastic film appropriately called "Mar-Not", or by lacquer.

Copper Alloys — If past history is any guide, the brass mills will set a high mark for beauty in their exhibits. Chase Brass & Copper Co., with its parent Kennecott Copper Corp., is an example of an integrated metallurgical operation. (American Brass Co. with Anaconda Copper Mining Co. is another.) Chase will show various steps in the transformation of ore to metal and fabricated parts for customer items, large and small, made by Waterbury Mfg. Co. division.

Classified List of Exhibitors

Steels (Plain and Alloy)

Allegheny Ludlum Steel Corp.—141
American Brake Shoe Co.—130
Arwood Precision Castings Corp.—1758
Carpenter Steel Co.—350
Crucible Steel Co. of America—104
Eaton Mfg. Co., Reliance Div.—912
Firth Sterling Steel & Carbide Corp.—421
Heppenstall Co.—1572
International Nickel Co., Inc.—230, 324
Janney Cylinder Co.—1327
Keystone Drawn Steel Co.—1965
Ohio Seamless Tube Co.—1820
Ryerson & Son, Inc., Joseph T.—318
Sandvik Steel, Inc.—402
Schnell Tool & Die Corp.—1453

High-Temperature Alloys

Allegheny Ludlum Steel Corp.—141
Alloy Engineering & Casting Co.—507
Alloy Metal Wire Co., Inc.—550
American Brake Shoe Co.—130
Arwood Precision Castings Corp.—1758
Carpenter Steel Co.—350
Crucible Steel Co. of America—104
Driver Co., Wilbur B.—521
Electro Alloys Div., American Brake Shoe Co.—130
Fahralloy Co.—1969
Firth Sterling Steel & Carbide Corp.—421
General Alloys Co.—204
Haynes Stellite Div., Union Carbide & Carbon Corp.—1202
Heppenstall Co.—1572
Howard Foundry Co.—501
International Nickel Co., Inc.—230, 324
Janney Cylinder Co.—1327
Kanthal Corp.—1266
Kennametal Inc.—1319
Michiana Products Corp.—1240
Ohio Steel Foundry Co.—1958
Rolock, Inc.—1810
Standard Alloy Co.—1250
Titanium Alloy Mfg. Div., National Lead Co.—1316
Wall Colmonoy Corp.—1131
Whitehead Metal Products Co., Inc.—1283

Stainless and Corrosion Resistant Steels

Allegheny Ludlum Steel Corp.—141
Alloy Engineering & Casting Co.—507
Alloy Metal Wire Co., Inc.—550
American Brake Shoe Co.—130
American Silver Co., Inc.—709
Arwood Precision Castings Corp.—1758
Carpenter Steel Co.—350
Crucible Steel Co. of America—104
Driver Co., Wilbur B.—521
Fahralloy Co.—1969
Firth Sterling Steel & Carbide Corp.—421
General Alloys Co.—204
Haynes Stellite Div., Union Carbide & Carbon Corp.—1202
International Nickel Co., Inc.—230, 324
Janney Cylinder Co.—1327
Metals & Controls Corp.—1816
Newark Wire Cloth Co.—1853
Ohio Steel Foundry Co.—1958
Ryerson & Son, Inc., Joseph T.—318
Sandvik Steel, Inc.—402
Titanium Alloy Mfg. Div., National Lead Co.—1316
Whitehead Metal Products Co., Inc.—1283

Light Metals and Alloys

Arwood Precision Castings Corp.—1758
Beryllium Corp.—1539
Dow Chemical Co.—730
Howard Foundry Co.—501
Metals & Controls Corp.—1816
Reynolds Metals Co.—1550
Rolle Manufacturing Co., Inc.—750
Titanium Metals Corp. of America—120
Upton Electric Furnace Co.—1519
Whitehead Metal Products Co., Inc.—1283

Heavy Nonferrous Metals and Alloys

Alpha Metals, Inc.—1862
American Brake Shoe Co.—130
American Brass Co.—241
American Nickeloid Co.—1378
American Silver Co., Inc.—709
Ampco Metal, Inc.—1217
Arwood Precision Castings Corp.—1758
Baker & Co., Inc.—1210
Beryllium Corp.—1539
Bridgeport Brass Co.—1035
Chase Brass & Copper Co., Inc.—1220
Haynes Stellite Div., Union Carbide & Carbon Corp.—1202
International Nickel Co., Inc.—230, 324
Janney Cylinder Co.—1327
Knapp Mills Inc.—808
Makepeace Co., D. E.—560
Malayan Tin Bureau—852
Mallory & Co., Inc., P. R.—1950
Metal & Thermit Corp.—430
Metals & Controls Corp.—1816
National Lead Co.—411
Philadelphia Bronze & Brass Corp.—1587
Rolle Manufacturing Co., Inc.—750
Scovill Mfg. Co.—1685
Tin Research Institute, Inc.—852
Titanium Alloy Mfg. Div., National Lead Co.—1316
Wall Colmonoy Corp.—1131
Whitehead Metal Products Co., Inc.—1283

For descriptions of other exhibits see p. 17 e. s. and p. 274 e. s.

Three engineering alloys will be featured — tellurium copper (high conductivity, machinable), "Telnic" bronze (tellurium-nickel-copper for strength and corrosion resistance), and "Phosnic" bronze (nickel-phosphorus-copper for hard-temper springs and other items).

Scovill Mfg. Co., to commemorate its 150 years, will recreate a casting shop of the early 1800's, when 17-oz. ingots were cast in banded molds, 5 or 10 per hr. Contrast with this the continuous casting at 30,000 lb. per hr. in Scovill's new mill (described in *Metal Progress* for January and February 1950). Equipment there is capable of making 2000-lb. coils of cold rolled brass, 24-in. wide. The exhibit will include a coil winder and unwinder operating in slow motion, and showing both sides of the metal strip.

Tin and its uses will be featured at the Show by Tin Research Institute and the Malayan Tin Bureau. Since the metal has been under governmental control since early in World War II, and the price has been pretty high, the Institute will stress the fact that (statistically) the metal is now in good supply and consequently could be put to the endless good uses already well established. (See *Metal Progress* article on this topic last month.) Promising new tin alloy coatings are available. Metal & Thermit Corp. will also exhibit pig tin. It may be remembered that a subsidiary of this firm has long operated a process for recovering tin from tinned steel scrap — and, during the last war, this conservation was extended to old tin cans, saved by millions of American housewives.

Producers of Metals and Alloys (Continued)

Zirconium. Titanium was the "wonder metal" of the Exposition a year ago. This year it may be zirconium — a metal which has reasonably good mechanical properties and corrosion resistance and a marked antipathy for wandering neutrons, useful for the construction of atomic reactors and atomic power plants. Titanium Alloy Mfg. Div. of National Lead Co. produces this metal and will display zirconium metal sponge, briquettes, ingots, and fabricated shapes. (P. S. — The Atomic Energy Commission is cooperating with the ASM to plan an extensive symposium on the metallurgy of zirconium for the Western Metal Congress in Los Angeles early next spring — Adv.)

Beryllium and its alloys will be promoted in an exhibit by the Beryllium Corp. highlighting various activities — mining and reduction of beryl ore, production of master alloys, ingot making and mill operations. Separately the exhibit will show case histories of successful applications of its alloys in many industries. ASM

Metals Manufacture
(Refining, Casting and Forging)

THERE'S ALWAYS something new, important and intriguing in the metal industry. Things move forward so rapidly that exhibitors at the National Metal Congress and Exposition can emphasize at least three aspects of this continuous progress — *(a)* labor or money-saving equipment for conventional plants; *(b)* more precise control devices; *(c)* equipment for performing conventional operations in an entirely new way.

Continental Industrial Engineers, Inc., will have examples of the first category, especially as it applies to heating furnaces in tube mills. Modern designs eliminate manual labor; tubes up to 48 ft. long are automatically charged, moved gradually through the hearths (on walking beams or alloy chains with alloy fingers) and discharged, properly heated, one at a time, as desired by the mill operator. The great area of these reheating or normalizing furnaces — 38 ft. long by 56 ft. wide — requires suspended roofs and carefully engineered burner arrangements.

An example of the second category mentioned above — more precise control devices — will be shown by Ajax Electrothermic Corp. in the form of a self-contained panel for induction furnaces used in melting or in heating for forging. A rotary knob adds capacitor units to the circuit one at a time without interrupting the electric power, but automatically opens the power circuit before a unit is removed. A second rotary switch eliminates knife switches and simplifies connections to the furnace. A third knob sets the voltage at the desired figure and a regulator maintains it there. Continuous regulation by such means increases the performance of melting furnaces and improves the power factor of systems supplying energy to groups of furnaces or billet heaters.

Old and new in melting procedures may be contrasted in the exhibits of Morrison Industries, Inc., and Eastman Kodak Co. Crucible melting is expedited in Morrison equipment by joining two furnaces like Siamese twins. A central column supports a burner-lid which can be swung from one furnace to the other. When flame is bathing one crucible to melt a charge, the waste gases are preheating the crucible in the other furnace and give up half or more of the heat eventually required for melting.

Eastman Kodak Co.'s division, Distillation Products Industries, will show a complete line of pumps, gages, valves, baffles and leak detectors for generating high vacuum. The new metals like titanium and molybdenum attain their remarkable properties only when free of atmospheric gases, either dissolved or combined. In their consolidation to ingot form, vacuums on the order of 1 micron mercury pressure (one millionth of an atmosphere) are desirable. Vacuum melting of certain magnetic alloys is a more recent development. Vacuums of the order of 10 microns Hg are useful in the dehydration of metal parts before coating with a corrosion preventive, while annealing of fine watch springs is done in a vacuum of 0.01 micron Hg (10^{-5} mm.).

Oxygen has already made a good name for itself in electric steel melting — rapid melting of heavy scrap, blowing the carbon down, raising bath temperature rapidly, flushing nitrogen and hydrogen out of the metal. As was discussed at some length in "Critical Points" in *Metal Progress* for July 1947, its wholesale use in bes-

semer converters and openhearths awaits a low-cost gas of reasonable purity. Air Products, Inc., believes its oxygen generators are as simple to operate as an air compressor. Single units (obtainable on lease) range in output from 300 to 12,000 cu.ft. per hr. — the latter will separate 12 tons of 99.5% and higher O_2 per day.

Foundry Equipment — Shell molding (which has received considerable editorial treatment in *Metal Progress* during the last 12 months) and necessary equipment will be the focus of attention at Mechanical Handling Systems, Inc. This new method of making castings to close dimensions will have its competition in a labor-saving machine exhibited by ABC Die Casting Machine Co. It is air operated with semiautomatic cycling and adjustable timing on closing of die, injection of molten zinc, opening of die. Its free cycling speed is 1000 shots per hr.

Castings that "weep" or "sweat" under hydrostatic or aerostatic test, even though they contain no visible or radiographic defects, have long been the bane of foundrymen. Impregnation of such castings with sodium silicate, styrene, or synthetic sealing compound is a well-recognized engineering operation. American Metaseal Corp. will show a self-contained unit for degreasing, preheating, evacuation to 29.5 in., drawing compound into the autoclave, imposing 100 psi. pressure, cleaning and curing at 250° F. Polyplastex Impregnation Corp. will also exhibit an improved resin sealant for castings.

Classified List of Exhibitors

Mill Equipment

Air Products, Inc.—1662
American Brake Shoe Co.—130
Baldwin-Lima-Hamilton Corp.—1520
Heppenstall Co.—1572
Milton Equipment Co.—1562
Superdraulic Corp.—1877
Sutton Engineering Co.—740
Tyler Mfg. Co.—1280

Ferro-Alloys

Cooper Metallurgical Associates—923
Kanthal Corp.—1266
Metal & Thermit Corp.—430
Titanium Alloy Mfg. Div., National Lead Co.—1316
Vanadium Corp. of America—618
Whitehead Metal Products Co.—1283

Melting Furnaces and Refractories

Air Products, Inc.—1662
Ajax Electrothermic Corp.—624
Ajax Engineering Corp.—624
American Gas Association—1901-1910
Continental Industrial Engineers, Inc.—1934
Distillation Products Industries, Div. of Eastman Kodak Co.—1428
Morrison Industries, Inc.—1804
National Research Corp.—1211
Ohio Crankshaft Co., Tocco Div.—1377
Stokes Machine Co., F. J.—1385

Die-Casting Machines

ABC Die Casting Machine Co.—1563

Forging Equipment

Ajax Electrothermic Corp.—624
Baldwin-Lima-Hamilton Corp.—1520
Gas Appliance Service, Inc.—1920
Morrison Industries, Inc.—1804
Selas Corp. of America—1601

Foundry Processes, Equipment and Supplies

Air Products, Inc.—1662
Ajax Engineering Corp.—624
American Metaseal Corp.—1138
Baldwin-Lima-Hamilton Corp.—1520
Bendix-Westinghouse Automotive Air Brake Co.—1710
Challenge Machinery Co.—932
General Chemical Div., Allied Chemical & Dye Corp.—1019
Mall Tool Co.—1276
Mechanical Handling Systems Inc.—1472
Peters-Dalton, Inc.—1410
Polyplastex Impregnation Corp.—927
Superdraulic Corp.—1877
Tincher Products Co.—1975
Titanium Alloy Mfg. Div., National Lead Co.—1316
Torit Mfg. Co.—1881
Wiegand Co., Edwin L.—1244

For descriptions of other exhibits see p. 17 c. s. and p. 274 c. s.

Markley Recuperative Twin Crucible Furnace Exhibited by Morrison Industries, Inc.

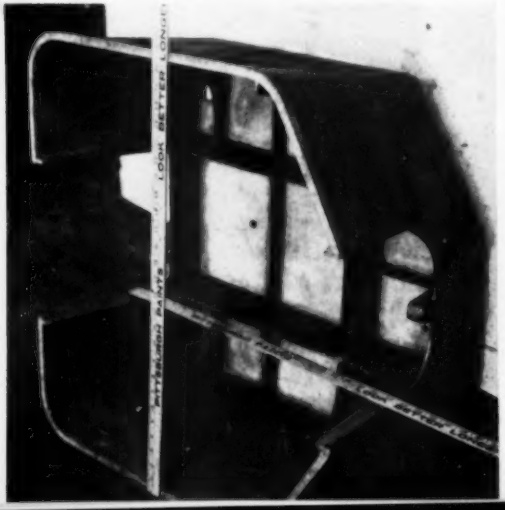
Metal Components

ANYONE WHO attempts a classification for a large group of related subjects or items discovers borderline cases which seemingly are *both* fish and fowl. Thus — where do "Metals and Alloys" (Group A in this classification) stop and "Metal Components" start? The former includes mill products ready for further fabrication, and the latter includes semifabricated or completely finished parts. A sound suggestion would be, however, to scrutinize the other if one group doesn't contain what you are looking for.

Castings are made by an art centuries old. It is a common saying that the older the art the less is known about it and the smaller the urge to change. This proverb is exactly wrong as far as the foundry industry is concerned, as will be proved by several exhibitors. In fact about 40 companies have contributed 100 sample castings to the Gray Iron Founders' Society demonstrating the adaptability and quality of various finishes, either hot-dipped, electroplated, or sprayed metallic coatings, or nonmetallic coatings including vitreous enamel and various organics. Not only is appearance improved but certain of these coatings increase the wear, heat and corrosion resistance of the old reliable gray iron.

Conventional methods of molding and pouring are in all but universal use, of course, but have been vastly improved through mechanization, sand control and metallurgical knowledge. Only by such means could Hingham Foundry produce the large aluminum alloy casting with thin walls shown in the engraving and exhibited by Kenneth F. Thomas Co. Advanced techniques also are fundamental to the 1630-lb. magnesium casting in the booth of Rolle Mfg. Co., Inc. — possibly the largest to date — a base for a mobile radar station.

Aluminum Alloy Sand Casting for Spectrograph Housing Cast by Hingham Foundry. Dimensions are 31 x 31 x 20 in., weight 55 lb. This and other complex castings in aluminum, magnesium and bronze will be displayed by Kenneth F. Thomas Co.



Three other casting methods have found important commercial application — die casting, centrifugal casting, and investment casting. The last mentioned is the old lost-wax molding process, which has been adapted to small engineering parts during the last decade. Precision Metalsmiths, Inc., in an operating exhibit, will show how these wax patterns are made in accurate permanent molds. (*Metal Progress* ran a completely illustrated story in September 1945 showing Haynes Stellite Co.'s method of manufacturing supercharger buckets in investment molds.)

Centrifugal casting was commercialized much earlier in this century and in fact was capable of such excellent work that Watertown Arsenal cast gun tubes (no less) centrifugally in 1925. About that same time Janney Cylinder Co. started promoting the sale of completely machined cylindrical parts made exclusively from centrifugal castings, and now has extended its range of alloys to include 20 bronzes, stainless steels, nickel alloys and high-strength irons.

United States Pipe & Foundry Co., one of the American pioneers in manufacturing cast iron water pipe in centrifugal molds, will show a new line of "Dual Metal" cylindrical products. One metal is poured into the spinning mold and the second metal follows after a short time interval. Outer and inner layers are metallurgically bonded together. Examples are grinding rolls (chilled iron outside, gray iron inside), textile and paper mill rolls (stainless steel outside, gray iron inside), and special combinations like carbon steel shell outside and "Ni-Hard" inside.

Forging, extrusion and stamping appear to merge, one operation into another. Forward and backward extrusion has received much recent attention in the American technical press. (See, for example, "Critical Points" in *Metal Progress* for May 1952.) Much of its interest lies in the ability to extrude shells or tubes, close to finished dimensions, from cold round slugs. National Cored Forgings Co., Inc., will exhibit forgings cored in four directions in the same plane, and without draft. Are these "forgings" or "extru-

sions"? Schnell Tool & Die Corp. will have a working model showing the tooling necessary to produce a round-bottomed cylinder 14½ in. diameter by 24 in. deep from a ⅜-in. diameter steel disk in a single operation. The main ram on its descent forms a flat-bottomed shell and continues down over a round-nosed punch, "reverse drawing" the shell into the finished cylinder. Loading, drawing and unloading are completely automatic in a 26-sec. cycle.

Indeed, there are almost unlimited possibilities — as demonstrated by Commercial Shearing and Stamping Co. — of using forged, stamped or extruded shapes of refined design as economical substitutes for assemblies in all sorts of mechanisms where strength, toughness, and wear resistance are required.

Powder Metallurgy for manufacturing precise parts with vanishing amount of scrap is also well known. A review of its history, present status and probable future was presented to *Metal Progress* readers in January 1952 by A. J. Langhammer, president of Amplex Mfg. Co., subsidiary of Chrysler Corp. This company will have an exhibit emphasizing the idea that the advantages of powder metallurgy are not limited to small parts but are also adapted to large finished machine parts. Giant oilite bearings, 12 in. o.d., 9⅝ in. i.d., 8 in. long, and weighing 100 lb., are in production by Amplex.

Tubular Products will be featured by at least four firms. Babcock & Wilcox Co., Tubular Products Division, will have on display a number of complex items for machines or pressure devices whose production is simplified by using carbon and alloy steel tubing as raw material. Small-diameter, butt welded tubing (using high-frequency electrical resistance methods) made of

Classified List of Exhibitors

Forgings

Allegheny Ludlum Steel Corp.—141
American Brass Co.—241
Ampco Metal, Inc.—1217
Chase Brass & Copper Co., Inc.—1220
Commercial Shearing and Stamping Co.—1616
Crucible Steel Co. of America—104
Haynes Stellite Div., Union Carbide & Carbon Corp.—1202
Heppenstall Co.—1572
International Nickel Co., Inc.—230, 324
Janney Cylinder Co.—1327
Mallory & Co., Inc., P. R.—1950
National Cored Forgings Co., Inc.—151
Philadelphia Bronze & Brass Corp.—1587
Reynolds Metals Co.—1550
Titanium Metals Corp. of America—120

Castings

Allegheny Ludlum Steel Corp.—141
Alloy Engineering & Casting Co.—507
American Brake Shoe Co.—130
American Non-Gran Bronze Co.—1946
Ampco Metal, Inc.—1217
Baldwin-Lima-Hamilton Corp.—1529
Casting Engineers, Inc.—805
Chase Brass & Copper Co., Inc.—1220
Crucible Steel Co. of America—104
Dow Chemical Co.—730
Electro Alloys Div., American Brake Shoe Co.—130
General Alloys Co.—204
Gray Iron Founders' Society, Inc.—1340
Haynes Stellite Div., Union Carbide & Carbon Corp.—1202
Hitchiner Mfg. Co., Inc.—817
Howard Foundry Co.—501
International Nickel Co., Inc.—230, 324
Janney Cylinder Co.—1327
Lynchburg Foundry Co.—1927
Mallory & Co., Inc., P. R.—1950
Michiana Products Corp.—1240
National Lead Co.—411
National Precision Castings Co.—1771
Ohio Steel Foundry Co.—1958
Philadelphia Bronze & Brass Corp.—1587
Precision Metalsmiths, Inc.—1461
Reynolds Metals Co.—1550
Rolle Mfg. Co., Inc.—750
Steel Founders Society of America—101
Thomas, Kenneth F.—1567
United States Pipe & Foundry Co.—702
Wall Colmonoy Corp.—1131
Whitehead Metal Products Co., Inc.—1283

Tubing and Other Mill Shapes

Allegheny Ludlum Steel Corp.—141
Alloy Metal Wire Co., Inc.—550
American Brass Co.—241
American Nickeloid Co.—1378
American Silver Co., Inc.—709
Ampco Metal, Inc.—1217
Avon Tube Div., Higbie Mfg. Co.—1961
Babcock & Wilcox Co., Tubular Products Div.—340
Beryllium Corp.—1539
Bridgeport Brass Co.—1035
Bundy Tubing Co.—1839
Chase Brass & Copper Co., Inc.—1220
Crucible Steel Co. of America—104
Dow Chemical Co.—730
H & H Tube & Mfg. Co.—1487
International Nickel Co., Inc.—230, 324
Keystone Drawn Steel Co.—1965
Makepeace Co., D. E.—560
Metals & Controls Corp.—1816
Milne & Co., A.—506
Ohio Seamless Tube Co.—1820
Pittsburgh Tube Co.—240
Precision Shapes, Inc.—1015
Reynolds Metals Co.—1550
Rochester Products, Div. of General Motors Corp—1031
Sandvik Steel, Inc.—402
Scovill Mfg. Co.—1685
Superior Tube Co.—1630
Titanium Metals Corp. of America—120
United States Pipe & Foundry Co.—702
Whitehead Metal Products Co., Inc.—1283

Stampings

American Brass Co.—241
American Nickeloid Co.—1378
Chase Brass & Copper Co., Inc.—1220
Commercial Shearing and Stamping Co.—1616
Globe Stamping Div., Hupp Corp.—1354
Heintz Mfg. Co.—1668
H P L Mfg. Co.—1951
Makepeace Co., D. E.—560
Mallory & Co., Inc., P. R.—1950
Newark Wire Cloth Co.—1853
Reynolds Metals Co.—1550
Schnell Tool & Die Corp.—1453
Titanium Metals Corp. of America—120

Powder Metals and Parts Production

Amplex Mfg. Co., Subs. of Chrysler Corp.—1954
Electric Furnace Co.—341
Precision Shapes, Inc.—1015
Reynolds Metals Co.—1550
Stokes Machine Co., F. J.—1335

For descriptions of other exhibits see p. 17 e. s. and p. 274 e. s.

Metal Components (Continued)

S.A.E. 1010 steel, terne coated, is fabricated by Avon Tube Division of Higbie Mfg. Co. into an infinite number of parts with hard-to-form bends, coils, swages or flares. Common applications are fuel and oil lines for gas and diesel engines, hydraulic and compressed gas lines, tubing for condensers or heaters for refrigerators and domestic appliances, and ordnance items.

Round, square, or oval tubing of brass or copper, either seamless, brazed ("Metalflo"), or with lockseam joints, fabricated into all sorts of small tubular parts for automotive, heating, air conditioning and refrigeration industries are also on display by H & H Tube & Mfg. Co. Finally, in addition to seamless tubing in various carbon, alloy and stainless steels, nickel alloys, beryllium copper — especially shaped tubes, capillary tubes, and precise tubing of exceedingly small diameter for hypodermic needles — Superior Tube Co. will show fabrication and test samples of seamless and welded titanium tubing, $\frac{1}{4}$ to $\frac{3}{4}$ in. diameter. Its superior corrosion resistance and strength-weight ratio will warrant its use in aeronautics, in medical and surgical instruments and in various branches of the chemical and food industry.

Tooling

A NOTABLE VARIETY of machine tools and accessories such as toolsteels, oils, dies and fixtures are on display. Throughout, the emphasis is on precision, adaptability and portability. Only a small sampling can be noted on this page, but it is indicative of what will be seen by the Exposition visitor.

Firth Sterling Steel & Carbide Corp. will demonstrate "Method X", wherein metal is removed cold by bombardment with electricity of high current density — a mechanical rather than a thermal action. *Metal Progress* described several aspects of the general process in August 1952, primarily as it applies to carbides and hard compacts. Firth Sterling equipment also extends this to difficult operations on more readily machinable stock. It is said that finishes of 26 micro-in. r.m.s. can be obtained directly in this manner. Dies can be cut out of prehardened steel blocks by Method X — even threaded holes made in carbide dies. The machine itself looks like a drill press.

A somewhat different application of this principle has been used for some years in the form of "disintegrators" for removing frozen studs or broken taps, drills or reamers. Metalmaster Div. of Clinton Machine Co., and Electro Arc Mfg. Co. both show small machines for this purpose, wherein the base (on casters) contains the electrical equipment and supports a work table, column and operating head. These machines are also capable of removing the bulk of the material from shaped holes in hard carbides.

DeWalt Inc., subsidiary of American Machine & Foundry Co., will have on exhibit a sprue cutting machine which "applies modern production methods to the cleaning room" (in their words). Full-circle traverse of horizontal arm can reach work either on table or floor adjoining. The motor-driven saw can also be swiveled through the lower half of the circle about its trunnion. Push buttons control arm elevator and saw motor; a flush-type saw arbor and an adjustable safety guard clear stumps of risers as they are cut away.

Any handy man about the house will lose himself if he looks in on O'Neil-Irwin Mfg. Co.'s line of "Di-Acro" benders, brakes, notchers, punch presses, rod parters, rollers and shears — hand operated for short runs on thin-gage materials, power operated for heavier metal and mass production. Their common denominator is that they make precision parts without dies, using built-in gages, stops or master templates instead. Mr. Handy Man would be surprised with the ease and neatness with which metal boxes, for example, can be formed of any shape in a Di-Acro brake equipped with fingers so graduated that sizes can be held accurately in steps of $\frac{1}{8}$ in.

Intense study of the mechanism of the cutting action and the role of cutting oils in machining and greases for cold forming has lifted the subject of lubricants out of the rule-of-thumb category. For example, Gulf Oil Corp.'s research and development subsidiary will show a model of its "Hi-Jet" device for delivering a stream of special oil at 400 psi. up from underneath into the angle between heel of tool and work — thus injecting the cooling lubricant into the exact

space where it is needed. This idea was discussed in "Critical Points" in *Metal Progress* for March 1952. "Critical Points" for May 1952 also described the phosphated surface which is necessary to hold lubricant on the surface of steel extrusions — matters which will be prominently displayed by Parker Rust Proof Co. along with its other protective materials for surface treatments. (In passing, it might be mentioned that two examples of editorial fallibility are contained in that one article. It failed to give Parker credit for the surface treatment without which cold extrusion is impossible, and did say that men at Frankford Arsenal supervised the American adaptation of the German cold extrusion process. They actually were at Watertown Arsenal.

L. R. Kerns Co. is promoting a "Dry-Film" which is used after phosphating prior to such heavy cold work as drawing a steel cartridge case. Preliminary phosphating is unnecessary for less severe work. For example, sheet steel blanks for enameled parts may be cleaned, dipped in a water solution of "Dry-Film" and dried. No other lubricant is necessary in the drawing dies — in fact would be detrimental, for the film is completely washed off by water, leaving a surface free from organics which interfere with successful enameling.

Classified List of Exhibitors

Toolsteels and Tool Materials

Allegheny Ludlum Steel Corp.—141
Carboloy Dept., General Electric Co.—816
Carpenter Steel Co.—350
Crucible Steel Co. of America—104
DoAll Co.—524, 623
Firth Sterling Steel & Carbide Corp.—421
Handy & Harman—110
Haynes Stellite Div., Union Carbide & Carbon Corp.—1202
Heppenstall Co.—1572
Kennametal Inc.—1319
Latrobe Steel Co.—1649
Makepeace Co., D. E.—560
Milne & Co., A.—506
National Diamond Laboratory—1477
National Lead Co.—411
New Hermes, Inc.—1478
Ryerson & Son, Inc., Joseph T.—318
Standard Die Set Mfrs., Inc.—1640
Starrett Co., L. S.—1843

Cut-Off Equipment

Allison Co.—1409
Campbell Div., A. C., American Chain & Cable Co., Inc.—706
Delta Power Tool Div., Rockwell Mfg. Co.—1650
de Sanno & Son, Inc., A. P.—1252
DeWalt Inc.—1120
DoAll Co.—524, 623
Griffith-Raguse & Co., Inc.—1310
Heller Machine Co.—1620
Manco Mfg. Co.—1480
Martindale Electric Co.—1762
Mid-West Abrasive Co.—1024
Porter-McLeod Machine Tool Co., Inc.—1271
Stone Machinery Co., Inc.—551
Wells Mfg. Co.—1678

Presses and Brakes

Baldwin-Lima-Hamilton Corp.—1520
Carlin Co., Inc., J. A.—1310
Dake Engine Co.—1761
DoAll Co.—524, 623
Industrial Air Controls Div., Bendix-Westinghouse Automotive Air Brake Co.—1710
Milton Equipment Co.—1562
O'Neil-Irwin Mfg. Co.—630
Precision Welder & Flexopress Corp.—842
Richards Co., J. A.—1277
Rodgers Hydraulic, Inc.—1558

Machine Tools and Accessories

American Pullmax Co., Inc.—1449
Atlas Press Co.—602
Black Drill Co.—1350
Bowser Technical Refrigeration, Div. Bowser, Inc.—1658
Buck Tool Co.—905
Carlin Co., Inc., J. A.—1310
Chicago Tool & Engineering Co.—1023
Clinton Machine Co.—610
Commander Mfg. Co.—531
Continental Tooling Service, Inc.—1027
Crane Packing Co.—811
Curtis Machine Corp.—937
Delta Power Tool Div., Rockwell Mfg. Co.—1650
Diversified Metal Products Co.—1767
DoAll Co.—524, 623
East Shore Machine Co.—1455
Electro Arc Mfg. Co.—1778
Elox Corp. of Michigan—1355
Ercona Corp.—920
Flexonics Corp.—534
Hammond Machinery Builders, Inc.—1130
Industrial Air Controls Div., Bendix-Westinghouse Automotive Air Brake Co.—1710
Magna Engineering Corp.—751
Mall Tool Co.—1276
Manco Mfg. Co.—1480
Martindale Electric Co.—1762
National Diamond Laboratory—1477
Nelco Tool Co., Inc.—1134
New Hermes, Inc.—1478
Nicholas Equipment Co.—911
Parker Machine Co., Inc.—1732
Porter-McLeod Machine Tool Co., Inc.—1271
Porter Precision Products Co.—1025
Precision Products Co.—1125
S & S Machinery Co.—1657
Sales Service Machine Tool Co.—1467
Sheldon Machine Co., Inc.—811
Taco Heaters Inc.—1829
Thomas, Kenneth F.—1567
Thread-All Sales Co.—918
Tyler Mfg. Co.—1280
Versa-Mil Co.—741
Walker-Turner Div., Kearney & Trecker Corp.—1941
Wells Mfg. Co.—1678

Cutting Oils and Forming Lubricants

Cities Service Petroleum, Inc.—1309
Clinton Machine Co.—610
Griffith-Raguse & Co., Inc.—1310
Gulf Oil Corp., Gulf Refining Co.—1515
Houghton & Co., E. F.—724
Johnson & Son, Inc., S. C.—1119
Kerns Co., L. R.—651
Oakite Products, Inc.—1715
Parker Rust Proof Co.—1909
Shell Oil Co.—1349
Socony-Vacuum Oil Co.—1876
Stuart Oil Co., D. A.—1251
Sun Oil Co.—1427
Swan-Finch Oil Corp.—1032
Texas Co.—717
Tide Water Associated Oil Co.—1450
Viking Sales, Inc.—928

Punches and Dies

Carboloy Dept., General Electric Co.—816
Firth Sterling Steel & Carbide Corp.—421
Kennametal Inc.—1319
O'Neil-Irwin Mfg. Co.—630
Porter Precision Products Co.—1025
Schnell Tool & Die Corp.—1453
Shell Oil Co.—1349
Standard Die Set Mfrs., Inc.—1640

For descriptions of other exhibits see p. 17 e. s. and p. 274 e. s.

Heat Treating

NO ONE SEGMENT of the metal industry can be accused of standing still, and the manufacturers of heat treating equipment seem to be treading constantly on the heels of progress. If yesterday's furnace could handle carburizing and dry cyaniding jobs, today's counterpart can also be used for clean hardening and other controlled atmosphere processes. For example, Surface Combustion Corp. will display a model of its "Allcase" batch-type furnace used for case and homogeneous carburizing, carbon restoration, dry cyaniding, clean hardening and bright annealing. A furnace for rapid heating of bar ends of Surface design is described in detail in the article starting on page 115 of this issue.

Ipsen Industries, Inc., has both batch-type and continuous-type furnaces for tempering in controlled atmosphere. The principles of the operation and a drawing of the latter, with provision for cooling at any desired speed without exposure to the outside air, are contained in this issue (page 123) of *Metal Progress*.

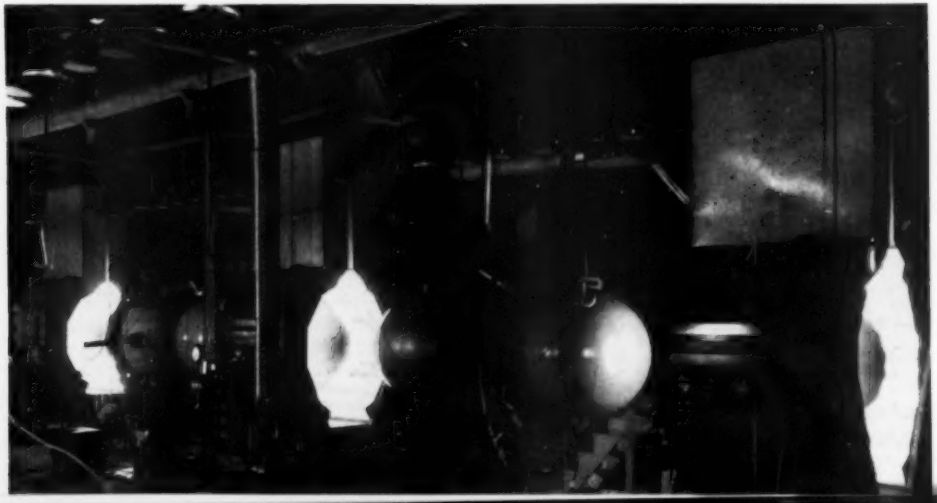
Atmospheres of desired purity and composition can be readily produced to meet practically every requirement of commercial heat treating. The commonest are based on the incomplete combustion of natural gas, resulting in a mixture of nitrogen, carbon monoxide and a hydrocarbon. Some alloys — notably the stainless steels — color badly in such gas mixtures, and for them *pure* cracked ammonia is suitable. Another use is for fluxless brazing. Baker & Co., Inc., will show equipment for catalytic decomposition of ammonia at a cost of ¼¢ per cu.ft. of mixed nitrogen and hydrogen (based on a cost of 17¢ per lb. of ammonia in 100-lb. cylinders). From such a gas pure nitrogen for heat treating highly reactive metals can be produced (at ¼¢ per cu.ft.) by burning the hydrogen in air, and removing the resulting moisture and last traces of hydrogen.

One of the newer applications for salt baths which will be shown by Ajax Electric Co., Inc., is differential hardening. The parts — gears in this demonstration — are placed on an arbor and spun by suitable trunnions and variable-speed drive so only the rims are immersed. As the gears rotate the teeth are heated to quenching temperature; salt adhering to them adequately protects the hot metal from oxidation and scaling when it is above the bath, in the air. Advantages of such differential hardening are that distortion is held to a minimum and machining operations on the unhardened portion, such as the hub of a gear, are greatly facilitated.

Another demonstration of work in a salt bath will be the brazing of aluminum radiator sections by the Upton Electric Furnace Co.

Certain production problems are more easily handled at the lower end of the thermal scale. Thus, adequate stabilization of steel for gages, "Jo blocks", aircraft bearings and precision gears, or for large parts such as lapping plates

Fostoria Pressed Steel Corp. Makes Specialized Equipment for Baking Finishes, for Preheating, Degreasing, Drying (or for Any Heating Operation in the Range of 800° F.) by Infrared Energy. In this line-up, 58-in. spherical floats for submarine nets are given successive treatments — zinc chromate, undercoat, and gray final coat. Baking time, 12 min. at 225° F. Finish is applied by electrostatic spray



Classified List of Exhibitors

Fuel-Fired Furnaces and Special Heating Equipment

American Gas Association Combined Exhibit—1901-1910
American Gas Furnace Co.—1701
Cincinnati Milling Machine Co.—1610
Continental Industrial Engineers, Inc.—1934
Delaware Tool Steel Corp.—1275
Diamond Iron Works, Inc., Mahr Mfg. Co. Div.—1557
Dow Furnace Co.—1315
Drever Co.—1980
Eclipse Fuel Engineering Co.—1926
Electric Furnace Co.—341
Gas Appliance Service, Inc.—1920
Hones, Inc., Charles A.—1912
Industrial Heating Equipment Co.—1439
Ipsen Industries, Inc.—131
Kanthal Corp.—1266
Kemp Mfg. Co., C. M.—1801
Kold-Hold Mfg. Co.—1462
Leeds & Northrup Co.—304
Lindberg Engineering Co.—330
Morrison Industries, Inc.—1804
Selas Corp. of America—1601
Spencer Turbine Co.—1942
Surface Combustion Corp.—231
Vapofier Corp.—1953
Waukee Engineering Co.—1223
Westinghouse Electric Corp.—1510

Electric Furnaces

Ajax Electric Co., Inc.—624
Ajax Electrothermic Corp.—624
Continental Industrial Engineers, Inc.—1934
Electric Furnace Co.—341
Harper Electric Furnace Corp.—1857
Harshaw Scientific Div., Harshaw Chemical Co.—1420
Hayes, Inc., C. I.—1262
Ipsen Industries, Inc.—131
Jensen Specialties, Inc.—1415
Kanthal Corp.—1266
Leeds & Northrup Co.—304
Lindberg Engineering Co.—330
Morrison Industries, Inc.—1804
National Research Corp.—1211
Ransburg Electro-Coating Corp.—1983
Sentry Co.—1324
Upton Electric Furnace Co.—1519
Williams, Brown & Earle, Inc.—1232

Induction Heaters

Ajax Electrothermic Corp.—624
Harshaw Scientific Div., Harshaw Chemical Co.—1420
Induction Heating Corp.—1870
Lepel High Frequency Labs., Inc.—1114
Lindberg Engineering Co.—330
National Research Corp.—1211
Ohio Crankshaft Co., Tocco Div.—1377
Ransburg Electro-Coating Corp.—1938
Scientific Electric Div., "S" Corrugated Quenched Gap Co.—1227
Westinghouse Electric Corp.—1510

Atmosphere Preparation Equipment

American Gas Association Combined Exhibit—1901-1910
Baker & Co., Inc.—1210
Bell and Gossett Co.—1772
Continental Industrial Engineers, Inc.—1934
Eclipse Fuel Engineering Co.—1926
Electric Furnace Co.—341
Hayes, Inc., C. I.—1262
Industrial Heating Equipment Co.—1439
Ipsen Industries, Inc.—131
Kemp Mfg. Co., C. M.—1801
Lindberg Engineering Co.—330
National Research Corp.—1211
Selas Corp. of America—1601
Vapofier Corp.—1953
Waukee Engineering Co.—1223
Westinghouse Electric Corp.—1510

Quenching Equipment and Mediums

American Gas Association Combined Exhibit—1901-1910
Bell and Gossett Co.—1772
Bowser Technical Refrigeration, Div. Bowser, Inc.—1658
Cities Service Petroleum, Inc.—1309
Continental Industrial Engineers, Inc.—1934
Eclipse Fuel Engineering Co.—1926
Electric Furnace Co.—341
Gulf Oil Corp., Gulf Refining Co.—1515
Houghton & Co., E. F.—724
Industrial Heating Equipment Co.—1439
Ipsen Industries, Inc.—131
Kold-Hold Mfg. Co.—1462
Lindberg Engineering Co.—330
Park Chemical Co.—312
Socony-Vacuum Oil Co.—1876
Sub-Zero Products Co.—1320
Sun Oil Co.—1427
Taco Heaters, Inc.—1829
Texas Co.—717
Tide Water Associated Oil Co.—1450
Viking Sales, Inc.—928
Waukee Engineering Co.—1223
Webber Appliance Co., Inc., Industrial Freezer Div.—1368

Supplies, Trays, Refractory Parts

Alloy Engineering & Casting Co.—507
Automatic Temperature Control Co., Inc.—1768
Bell and Gossett Co.—1772
Eclipse Fuel Engineering Co.—1926
Electro Alloys Div., American Brake Shoe Co.—130
Fahralloy Co.—1969
General Alloys Co.—204
Houghton & Co., E. F.—724
Lindberg Engineering Co.—330
Michiana Products Corp.—1240
Newark Wire Cloth Co.—1853
Ohio Steel Foundry Co.—1958
Park Chemical Co.—312
Rolock, Inc.—1810
Standard Alloy Co.—1250
Whitehead Metal Products Co., Inc.—1283

Vacuum Furnaces

Distillation Products Industries (Div. of Eastman Kodak Co.)—1428
National Research Corp.—1211
Stokes Machine Co., F. J.—1385

Industrial Ovens

Fostoria Pressed Steel Corp.—1571
Gehnrich & Gehnrich, Inc.—1816

Commercial Heat Treating Services

Metlab Co.—1607
Rex Co., J. W.—1750
Scott & Son, Inc., C. U.—1228

For descriptions of other exhibits see p. 17 e. s. and p. 274 e. s.

and milling machine beds may be achieved by one or more refrigerations at −120° F. in a cold-chamber unit such as the ones to be exhibited by Sub-Zero Products Mfg. Co. and Bowser, Inc. Shrink-fit assembly, in which one part is chilled and the other heated, has certain advantages and a safety margin over the old-fashioned scheme of forcing the parts together in a hydraulic press. Subzero quenching is also utilized in some tool rooms to reduce the amount of retained austenite in quenched toolsteel prior to tempering.

Industrial Freezer Division of Webber Appliance Co., Inc., will display a test chamber with controlled low temperature, high temperature and humidity. Vacuum can be added which will simulate altitudes to 125,000 ft., useful for

Cincinnati Milling Machine Co.'s "Flamatic" Engaged in the Production Hardening of Crankshafts for Refrigerator Units. The fuel gas used can be acetylene, propane or natural gas

testing small parts under simulated climatic and atmospheric conditions.

Another use for refrigeration to be shown by Bowser Technical Refrigeration Division of Bowser, Inc., is the chilling unit for cutting oils. Cutting fluids that have been properly cooled to about 68° F. are said to help maintain closer tolerances during the machining operation.

American Gas Furnace Co. has recently completed a unique double quenching tank for use in tandem with any of its heat treating machines. The device will be described in some detail next month in *Metal Progress*, but essentially consists of two identical tanks set side by side, each containing drag-out mechanisms and quenchant circulators. One tank contains a quenchant, the other another quenchant of any sort adapted to current production. A flow of parts in production can be quenched in one or the other by moving the proper tank up to the furnace. Change can be made in a minute.

Supplementary items of heat treating equipment to be displayed will include quench oil cooling systems by Bell & Gossett Co. and Taco Heaters, Inc.; Eclipse Fuel Engineering Co.'s air and gas mixer, set by a knurled screw; and a conveyer belt by Electro Alloys Division of American Brake Shoe Co. for operation at high temperature. This belt is so designed as to eliminate "crankshafting" of pins at link-ends.

Temperature Indicators and Fuel Controls

As EVERYONE knows, electronics have invaded the field of pyrometry and temperature control. While the physical principles that underlie today's thermoelectric, radiation and optical sensing elements remain as they were in 1921 when Foote, Fairchild and Harrison of the National Bureau of Standards wrote their classic "Pyrometric Practice", delicate mechanisms in the indicating, recording and control equipment have largely been replaced by rugged assemblies of multiplier tubes. The result is that operations and equipment once confined to the laboratory are now commonplaces in the plant, and each of the manufacturers participating in the National Metal Congress and Exposition offers a somewhat bewildering array of devices.

Take, for example, the panel at the bottom of the opposite page controlling eight furnaces and auxiliary operations. Prominent in this installation by Wheelco Instruments Division of Barber-Colman Co. are "Capacilogs" (direct-reading strip-chart recorders) which are available in three general types: *(a)* single-point, *(b)* multipoint recorders for six variables, and *(c)* pneumatic, for air-operated control systems. A new Wheelco accessory is the "Capaciline", an auxiliary containing a relay, transformer, electrolytic capacitors, and voltage selector — no tubes, motors or cams — so designed to minimize the "on" and "off" variation in the control instrument and dampen the swings of temperature to either side of the set point.

Leeds & Northrup Co. pioneered the potentiometer for measuring the electromotive force generated at the thermocouple's hot junction, and have brought it to a high state of perfection as the basis of complete temperature control systems. Also L&N "Rayotubes", wherein the radiation from a hot surface generates a small electric potential which is then measured, have

For descriptions of other exhibits see p. 17 e. s. and p. 274 e. s.

become indispensable for warning when furnace roofs or other spots become too hot for safety. Small-Target Rayotubes will be exhibited; they are designed to measure and control temperatures during induction heating where visible heated area is only 0.1 in. wide.

Pyrometer Instrument Co., Inc., also will show a "Micro-Optical Pyrometer" adapted to measure surface temperatures of extremely small items, and for use at unusually great distances from the hot object.

Tempil® Corp. utilizes crayon marks, liquid coatings, or pellets to indicate temperatures. Many special problems have been solved with these materials of sharp melting point, such as determining the temperature limits in the heat treatment of aluminum alloys.

Weston Electrical Instrument Corp. has a feature item on display in the form of a new single-point recorder of the potentiometer type in which all servicing is done from the front. For example, the chart frame can be swung aside 180° when replacing a roll of chart. The main frame, carrying visual scale, pen, indicator and actuating devices, also swings 180° revealing the amplifier. Meanwhile, the instrument continues in operation during minor servicing.

Program controllers, shown by Minneapolis-Honeywell Regulator Co.'s Industrial Division, suit almost any heat treating operation, large or small. For example, a variety of switches can be provided in the "ElectroniK" Strip Chart Program Controller to adjust heating or cooling rates, to start or stop soaking periods or to actuate visual or audio warnings — all this in addition to its temperature measurement, indicating, recording and controlling components.

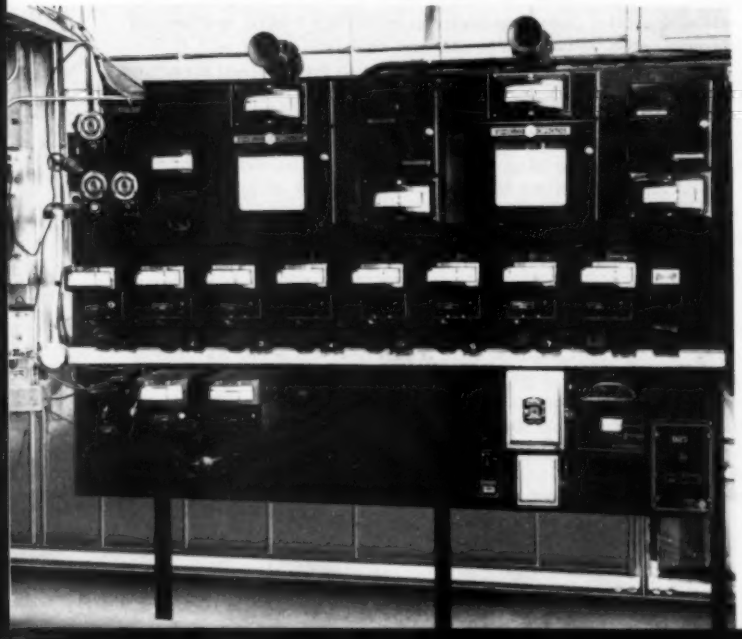
New fuel-air ratio control systems record and control temperature, fuel flow and air flow — the latter two being automatically proportioned at all firing rates. An electronic integrator can also be built into these instruments so the consumption of fuel is at all times accurately accounted for.

Classified List of Exhibitors

Indicators and Recorders

Automatic Temperature Control Co., Inc.—1768
Baldwin-Lima-Hamilton Corp.—1520
General Electric Co., Apparatus Div.—251
Illinois Testing Labs., Inc.—1457
Leeds & Northrup Co.—304
Minneapolis-Honeywell Regulator Co., Industrial Div.—211
Olsen Testing Machine Co., Tinius—1419
Partlow Corp.—1577
Pyrometer Instrument Co., Inc.—1729
Selas Corp. of America—1601
Superdraulic Corp.—1877
Tempil® Corp.—155
Weston Electrical Instrument Corp.—1011
Wheelco Instruments Div., Barber-Colman Co.—641

Various Wheelco Recorders, Controllers, Indicators, Combustion Safeguards and Auxiliary Equipment for Furnaces at Armstrong-Blum Mfg. Co., Makers of Hacksaws



Pyrometers

General Electric Co., Apparatus Div.—251
Illinois Testing Laboratories, Inc.—1457
Leeds & Northrup Co.—304
Minneapolis-Honeywell Regulator Co., Industrial Div.—211
Pyrometer Instrument Co., Inc.—1729
Wheelco Instruments Div., Barber-Colman Co.—641

Gas Samplers and Analyzers

American Gas Association Combined Exhibit—1901-1910
Electric Furnace Co.—341
National Research Corp.—1211
Williams, Brown & Earle, Inc.—1232

Automatic Fluid and Pressure Controls

Automatic Temperature Control Co., Inc.—1768
Leeds & Northrup Co.—304
Minneapolis-Honeywell Regulator Co., Industrial Div.—211
National Research Corp.—1211
Partlow Corp.—1577
Superdraulic Corp.—1877

Welding and Associated Processes

IN THE COMPARATIVELY few years which have elapsed since the various welding systems — thermit, gas, arc and resistance — have moved out of repair and job shops into production lines, a large number of special machines have been created and special adaptations invented to handle special problems. Much emphasis is placed on such new items by exhibitors in the National Metal Congress and Exposition. However, the familiar oxy-acetylene cutting equipment is still being refined for repetitive work, large or small, and arc welding machines are likewise receiving much attention.

For example, Lincoln Electric Co. has new models of alternating current welding machines of 300, 400, and 500 amp. capacity, and a 600-amp. gasoline-driven unit. Also featured will be the "twin-arc process of hidden-arc welding", wherein two electrodes are fed in so as to deposit metal in a single crater, which practically doubles the welding speed on long, straight seams in steel plate construction.

All the advantages of direct current welding are given by Harnischfeger Corp. Welding Division's "DC-200 Rectifier Welder Unit", which converts 60-cycle, 3-phase power supply into a 200-amp., 40-volt (rated) welding current by a rectifier rather than a motor-generator set. One knob controls the action, and the equipment has no moving coils or cores, only stationary electrical units requiring minimum maintenance.

The problem of protecting the puddle of metal in the seam being welded (a matter largely taken care of by the combustion gases in oxy-acetylene welding) has been given much study by manufacturers of arc welding equipment and electrodes ever since 1918 when A. O. Smith Corp. pioneered the cellulose covering. (That firm, by the way, will have a historical display of its electrodes from the first to the most recent one developed by its research laboratory.) In addition to electrodes covered with slag-forming ingredients, there is, of course, Linde Air Products Co.'s "Unionmelt" process where the arc is submerged in a protective, conductive powder. Promoted more recently is the scheme of blowing an inert gas (argon or helium) around the bare electrode. For the last mentioned, Air Reduction Co. will exhibit manual and automatic welding heads and accessories (tradenamed "Aircomatic") for such hard-to-weld metals as aluminum and its alloys, bronzes, nickel alloys and stainless steels. In this equipment the bare filler wire is fed automatically from a reel through the "gun". Viking Sales, Inc., will display a self-contained inert-arc welder — a hand-truck mounted cabinet containing transformers, amperage controls and various connectors for gas cylinder, electric lines and cooling water.

Obviously, the nature of the weld rod or other joining material is of greatest importance in making welds of high quality. Arcos Corp. has recently turned attention to a low-hydrogen family of alloys; control of hydrogen insures against underbead cracking — a most insidious defect — and the alloys have compositions which are low in strategic elements yet adapted to low-alloy high-tensile steels and even to the much harder armor plate.

Another aspect of welding is that done at lower temperatures, either to avoid changing the properties of the parts joined or for more economical production. Handy & Harman has long promoted "Easy-Flo" and "Sil-Fos" silver brazing alloys for such purposes — materials which have proven their worth in both manual and furnace brazing of common metals, and for difficult jobs such as tipping tools with cemented carbides.

Surface alloying at low heat is also the principle of the alloys manufactured by Eutectic Welding Alloys Corp. In this Exposition, Eutectic's Chemotec Division will show a method for bonding metals *without* heat. Chemotec's advance publicity does not tell how it is done, but does show that a 1-sq.in. butt joint will hold a 125-lb. girl off the floor, so the skeptical metallurgist may well visit the exhibit and see for himself.

A tricky welding job which should attract instant attention of the casual onlooker is the welding of studs, bolts or pins to sheet metal with a hand tool. Three firms show such equipment: Nelson Stud Welding Division of Gregory Industries, Inc. (the pioneering company in this field), has several new developments, including a scheme for welding aluminum studs to aluminum sheet wherein an inert gas nozzle is attached to the standard Nelson stud gun. KSM Products, Inc., features a box about the size of a large suitcase containing selenium rectifiers and the circuit breakers. Graham Mfg. Corp. will show its "6000-A" portable projection welder especially devised for small attachments, like steel pins or nails for affixing insulation to sheet metal air-conditioning ducts.

Successful spot welding of the strong aluminum alloys needs, as is well known, clean metal and a rigidly accurate cycle of squeeze, welding current, and "forging" pressure. For some alloys preheat and postheat are also desirable, as well as a correct current decay. Rapid action through jaws with deep throat and with pressures up to 5000 lb. requires most advanced mechanical and electrical design. Progressive Welder Sales Co. will exhibit such equipment featuring electrical circuits devised by Weltronic wherein three tubes connected to the three phases of incoming power fire in sequence five times, whereupon three others fire five times in sequence in the opposite direction, all being so timed that 60-cycle, three-phase current is transformed into 12-cycle, single-phase current. The characteristics of this current are such that a good spot weld can be made during one half-cycle. (When welding with high frequency, the weld nugget cools during the "off" periods between current pulsations, which in effect makes the first cycle of welding current the only effective one.)

Raytheon Mfg. Co. will operate in its exhibit "Stored Energy Weldpower Control Units" in which energy from a rectified alternating current is accumulated so any amount up to 3000 amp. is delivered at low voltage to the welding circuit in 0.003 to 0.016 sec., as desired. From 60 to 120 spots per minute can be welded in thin-gage metals having high electrical or thermal conductivity. Such equipment has been particularly applicable to the manufacture of medical, dental, electronic and aircraft instruments.

Classified List of Exhibitors

Flame Welding and Cutting, Equipment and Supplies

Air Products, Inc.—1662
Air Reduction Sales Co.—1623
American Brake Shoe Co.—130
American Brass Co.—241
American Pullmax Co., Inc.—1449
Arcos Corp.—309
Baldwin-Lima-Hamilton Corp.—1520
Chicago Tool & Engineering Co.—1023
Eutectic Welding Alloys Corp.—1001
Heath Engineering Co.—916
Linde Air Products Co.—1202
Metal & Thermit Corp.—430
National Cylinder Gas Co.—1989
National Torch Tip Co.—1372
Smith Welding Equipment Corp.—1828
Westinghouse Electric Corp.—1510
Whitehead Metal Products Co., Inc.—1283

Arc Welding and Electrodes

Air Reduction Sales Co.—1623
Alloy Rods Co.—448
American Brake Shoe Co.—130
American Brass Co.—241
Ampco Metal, Inc.—1217
Arcair Co.—1132
Arcos Corp.—309
Baldwin-Lima-Hamilton Corp.—1520
Cam-Lok Div., Empire Products, Inc.—1116
Chicago Tool & Engineering Co.—1023
Clinton Machine Co.—610
Erico Products, Inc.—1482
Eutectic Welding Alloys Corp.—1001
Graham Mfg. Corp.—933
Harnischfeger Corp.—1525
Industrial Air Controls Div., Bendix-Westinghouse Automotive Air Brake Co.—1710
International Nickel Co., Inc.—230, 324
K S M Products, Inc.—834
Lincoln Electric Co.—140
Linde Air Products Co.—1202
Metal & Thermit Corp.—430
Miller Electric Mfg. Co.—631
National Carbon Co., Union Carbide & Carbon Corp.—1202
National Cylinder Gas Co.—1989
Nelson Stud Welding Div., Gregory Industries, Inc.—1850
Progressive Welder Sales Co.—1105
Smith Corp., A. O.—150
Titanium Metals Corp. of America—120
Viking Sales, Inc.—928
Weldwire Co., Inc.—1383
Westinghouse Electric Corp.—1510
Whitehead Metal Products Co., Inc.—1283
Wiegand Co., Edwin L.—1244

Resistance Welding

Alloy Metal Wire Co., Inc.—550
Baldwin-Lima-Hamilton Corp.—1520
DoAll Co.—524, 623
General Electric Co., Apparatus Div.—251
Mallory & Co., Inc., P. R.—1950
Miller Electric Mfg. Co.—631
National Welding Supply Assoc.—1380
Precision Welder & Flexopress Corp.—842
Progressive Welder Sales Co.—1105
Raytheon Mfg. Co.—1815
Sciaky Bros., Inc.—1719
Scientific Electric Div., "S" Corrugated Quenched Gap Co.—1227
Viking Sales, Inc.—928
Whitehead Metal Products Co., Inc.—1283

Brazing and Soldering (Manual or Automatic)

Alpha Metals, Inc.—1862
American Gas Association Combined Exhibit—1901-1910
American Platinum Works—1972
American Silver Co., Inc.—709
Baldwin-Lima-Hamilton Corp.—1520
Continental Industrial Engineers, Inc.—1934
Electric Furnace Co.—341
Eutectic Welding Alloys Corp.—1001
Gas Appliance Service, Inc.—1920
Handy & Harman—110
National Lead Co.—411
Selas Corp. of America—1601
Viking Sales, Inc.—928
Westinghouse Electric Corp.—1510
Whitehead Metal Products Co., Inc.—1283

Fasteners

Acme Steel Products Div., Acme Steel Co.—1977
Allen Mfg. Co.—1825
American Machine & Foundry Co.—1124
Baldwin-Lima-Hamilton Corp.—1520
Chicago Rivet & Machine Co.—1819
Eaton Mfg. Co., Reliance Div.—912
Elastic Stop Nut Corp. of America—640
Erico Products, Inc.—1482
Goodrich Co., B. F.—617
Graham Mfg. Corp.—933
Heli-Coil Corp.—1955
K S M Products, Inc.—834
Manco Mfg. Co.—1480
Nelson Stud Welding Div., Gregory Industries, Inc.—1850
Southco Div., South Chester Corp.—1026
Stimpson Co., Inc., Edwin B.—695
Super-Grip Anchor Bolt Co., Inc.—1481
Tinnerman Products, Inc.—1330
Waldes Kohinoor, Inc.—1915
Whitehead Metal Products Co., Inc.—1283

Positioners

Acme Mfg. Co.—1716
Aronson Machine Co.—718

Thermit Welding

Metal & Thermit Corp.—430

Cleaning and Finishing Equipment and Supplies

METHODS, equipment and supplies for final operations on metal parts — pickling, cleaning, degreasing, polishing, electroplating, rust prevention, coloring, enameling, painting — are matters of increasing importance to metals engineers and consequently we find that members of the American Society for Metals have supervision of such departments in most large shops. For that reason also *Metal Progress* has so many articles on their problems that they have become monthly features.

For example, Allen G. Gray, consulting editor, discusses abrasive tumbling as a finishing operation on p. 104 of this issue. Along similar lines, American Wheelabrator & Equipment Corp. will be glad to show any visitor to the National Metal Congress and Exposition how a "Wheelabrator" Airless Blasting Cabinet will clean long cylindrical objects of rust or dirt. As the shafting, rods, tubes or cylinders roll over and over, metallic abrasive is thrown against them; the result is a clean, matte surface with excellent "tooth" for paint or other coatings.

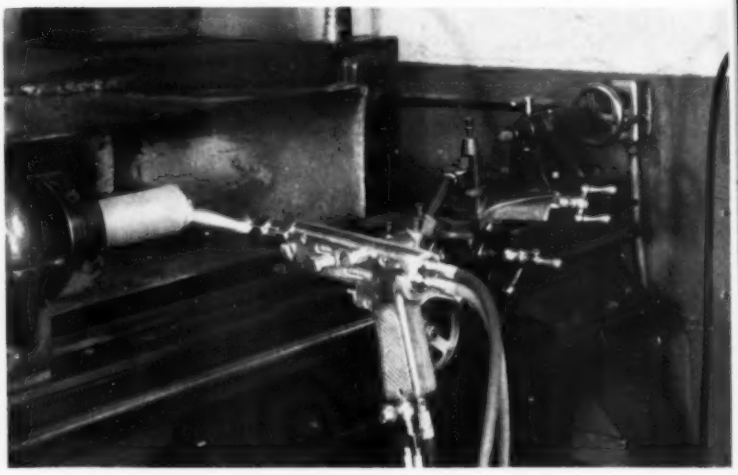
Enthone, Inc., features a rapid derusting process for irons and steels which derusts and cleans simultaneously, since the solution contains a detergent. In fact, zinc or cadmium salts may be added and the object comes out covered with a thin film of protective metal. The work is made cathodic by direct current at 3 to 6 volts; amperage depends on its size and the desired speed of action. Anodes are 1-in. carbon blocks which line the sides of the tank. By virtue of the alkaline nature of the bath, there is no subsequent rusting.

The equipment for vapor degreasing deteriorates rapidly unless made of stainless steel. Galvanizing is the only substitute, and that is short lived. Topper Equipment Co. is promoting a plastic coating ("Circlad") which will double the life of zinc coatings. It is cheaply applied to new equipment at the factory.

Chemical rust preventives for all sorts of alloys — perhaps one should say they delay natural oxidation rather than prevent it — are available in such large number that they appear to be tailor-made for a multitude of circumstances. Parker Rust Proof Co. will feature no less than eight surface treatments for preservation and coloring. Two new products promoted by Oakite Products, Inc., are applicable to nonferrous metals — "Oakite Composition No. 95", an electrolytic conditioner for zinc-base die castings prior to plating, and "Oakite Composition No. 60", designed to give a faster, deeper, more uniform etch on aluminum, leaving a velvety appearance. The solution avoids some severe troubles which have plagued earlier ones: it fouls very slowly by sludging and produces no hard scale on tank or heating coils. The Diversey Corp.'s "Aluminux" is also a granular alkaline compound for etching solutions. A 2-min. immersion is said to be sufficient to give aluminum reflectors a superior and lasting luster. (See also "HAE Coatings on Magnesium" in last month's *Metal Progress.*)

Plating and Metallizing — Frederic B. Stevens, Inc., will have a fully automatic barrel plating machine in operation as well as selenium

Wall Colmonoy "Model C Spraywelder" Overlaying a Cylindrical Surface With Hard Alloy Powder



rectifiers for either single-phase or 3-phase power. Three standard units are available which deliver direct current at 6, 9 or 12 volts; they may be used as single units or in multiple. This rectifier, consisting of a series of dry disks, each one a composite of front electrode, back electrode and selenium layer, delivers high current densities at high voltages.

Metallizing, which is a rather old process of spraying a surface with metal (a powder or a mist melted from wire) carried in an oxy-acetylene flame, has been adapted by Wall Colmonoy Corp. for hard facing alloys. An improved "spraywelder" pistol and powder mixer ("carburetor") produces a uniform overlay on a grit-blasted surface; this overlay is then fused by a welding flame and finish ground.

F. J. Stokes Machine Co. will operate a small unit demonstrating the metallizing in vacuum of small toys and ornaments of powder metal, castings or plastic.

Polishers — The "Review of Metal Cleaning and Finishing Since the War", printed in *Metal Progress* last January, mentioned the growing replacement of buffing and polishing wheels by backstand equipment and endless belts loaded with abrasive. At least three exhibitors will feature such devices.

Curtis Machine Division of Lincoln Park Industries, Inc., will have a "Curtis '600' Straight-O-Matic" on display, a cabinet enclosing belt polishers for smoothing either one or both sides of strip metal as it is fed through the machine from outside reels. The abrasive belts can be operated either dry or wet, depending on the requirements.

Hammond Machinery Builders will show its "Model VRO Variable Speed Polishing Lathe", a tandem machine with two backstands, polishing stations and a built-in dust collector.

Production Machine Co. has a backstand adaptation to its "Type 101" centerless tube polishing machine wherein an abrasive belt can be substituted for the polishing wheel whenever desired. A wide range of finishes can be obtained with various grits of belts.

Classified List of Exhibitors

Pickling, Cleaning, Degreasing

Alvey Ferguson Co.—530
American Cyanamid Co.—1344
American Wheelabrator & Equipment Corp.—1749
Blakeslee & Co., G. S.—540
Detrex Corp.—1849
Diversey Corp.—646
Enthone, Inc.—1867
Eutectic Welding Alloys Corp.—1001
General Chemical Div., Allied Chemical & Dye Corp.—1019
Houghton & Co., E. F.—724
Kelite Products, Inc.—1260
Kerns Co., L. R.—651
Kold-Hold Mfg. Co.—1462
Metalweld, Inc.—1272
Morrison Industries, Inc.—1804
Oakite Products, Inc.—1715
Osborn Mfg. Co.—729
Pangborn Corp.—901
Parker Rust Proof Co.—1909
Phillips Mfg. Co., Inc.—635
Rolock, Inc.—1810
Solventol Chemical Products, Inc.—512
Topper Equipment Co.—1351
Turco Products, Inc.—1028
Udylite Corp.—216
Wiegand Co., Edwin L.—1244

Electroplating and Metallizing

Distillation Products Industries (Div. of Eastman Kodak Co.)—1428
Diversey Corp.—646
Enthone, Inc.—1867
General Chemical Div., Allied Chemical & Dye Corp.—1019
International Nickel Co., Inc.—230, 324
Kold-Hold Mfg. Co.—1462
Metal & Thermit Corp.—430
Metalweld, Inc.—1272
National Research Corp.—1211
Peters-Dalton, Inc.—1410
Stevens, Inc., Frederic B.—244
Stokes Machine Co., F. J.—1385
Udylite Corp.—216
Wall Colmonoy Corp.—1131
Wiegand Co., Edwin L.—1244

Grinding Wheels and Abrasive Belts

Acme Mfg. Co.—1716
Curtis Machine Corp.—937
de Sanno & Son, Inc., A. P.—1252
DoAll Co.—524, 623
Griffith-Raguse & Co., Inc.—1310
Hammond Machinery Builders, Inc.—1130
Harshaw Scientific Div., Harshaw Chemical Co.—1420
Kerns Co., L. R.—651
Mid-West Abrasive Co.—1024
Production Machine Co.—1540
Stevens, Inc., Frederic B.—244

Rust Preventives and Paints

Cities Service Petroleum, Inc.—1309
Detrex Corp.—1849
Diversey Corp.—646
Griffith-Raguse & Co., Inc.—1310
Gulf Oil Corp.—1515
Houghton & Co., E. F.—724
Johnson & Son, Inc., S. C.—1119
Kelite Products, Inc.—1260
Kerns Co., L. R.—651
Metalweld, Inc.—1272
Oakite Products, Inc.—1715
Parker Rust Proof Co.—1909
Peters-Dalton, Inc.—1410
Ransburg Electro-Coating Corp.—1983
Scientific Electric Div., "S" Corrugated Quenched Gap Co.—1227
Shell Oil Co.—1349
Socony-Vacuum Oil Co.—1876
Tide Water Associated Oil Co.—1450
Turco Products, Inc.—1028

Buffers and Polishers

Acme Mfg. Co.—1716
Curtis Machine Corp.—937
Diversey Corp.—646
Globe Stamping Div., Hupp Corp.—1354
Griffith-Raguse & Co., Inc.—1310
Harshaw Scientific Div., Harshaw Chemical Co.—1420
Industrial Tectonics, Inc.—919
Mall Tool Co.—1276
Nicholas Equipment Co.—911
Osborn Mfg. Co.—729
Production Machine Co.—1540
Standard Electrical Tool Co.—903
Stevens, Inc., Frederic B.—244

Equipment for Purification of Solutions

Selas Corp. of America—1601
Sparkler Mfg. Co.—1875

For descriptions of other exhibits see p. 17 e. s. and p. 274 e. s.

Testing and Inspection Equipment

ELECTRONS and electronics and radiations of various sorts (ultrasonic, X and gamma) have invaded the field of metallurgical testing and inspection — all for the best when speed, sensitivity and scope are considered. Even in tensile testing machines, where the study of the strength of materials began a century ago, Baldwin-Lima-Hamilton Corp. electronically controls the straining platen of its "Baldwin-Emery SR-4" at any desired speed up to "impact" rates of 11 ft. per sec.

Tinius Olsen Testing Machine Co. will feature its new "Universal Electromatic Testing Machine", with four scale ranges (120, 1200, 6000 and 12,000 lb.) and an accuracy of 1 lb. in 1200, with load indicated by an electronic attachment to a torque bar. Olsen has also recently designed a unit for testing radioactive metals while contained in an external protective chamber, with nothing but a single wire connecting the testing and indicating mechanisms.

Riehle Testing Machines Division of American Machine and Metals, Inc., the pioneer American manufacturer of screw-power type (1870) tensile machines, has eliminated the weaknesses of the old mechanical drives by an electronically controlled device for infinitely variable speed of the driving motors. Rotating a single knob does the trick. (Riehle will also exhibit for the first time a greatly improved Izod impact machine.)

Philips Electron Microscope EM-100, With Finger-Tip Controls, Electronic Focusing and Exposure Meter, Is Entirely Self-Contained With no External Pumps or Liquid-Air Traps

Microscopes — The visitor to the National Metal Congress and Exposition whose job requires him to know something about the inner structure of metals will find many examples of necessary equipment — optical microscopes, electron microscopes, X-ray diffraction equipment, radiographic equipment, microhardness testers. Bausch & Lomb Optical Co. will feature a device about the size of a folding pocket camera which can be placed over the eyepiece of a desk-type microscope without interfering with the ocular system for focusing and search and yet can take a succession of exposures on a roll of 35-mm. film. Another new feature is a Polaroid Land camera which handles 2¼ x 3¼-in. film pack in connection with a reflex back so the operator can inspect the field at full size on a viewing screen before making the exposure.

American Optical Co.'s new metallograph, illustrated on page 94, is a model of convenience, containing numerous additional optical devices for polarized light and phase and bright-field illumination for the study of anisotropic metals, inclusions, and differences in level on the polished specimen.

Similarly compact is North American Philips Co. Research and Control Instrument Division's large-field electron microscope with screen magnifications from 1000 to 60,000 diameters and resolution of 30 Angstrom units. A 40-exposure roll of film is used. Special features are an oscillator for determining exact focus, and built-in photometer to measure correct exposure time.

Returning to optical instruments, a compact and handy Vickers projection microscope is on display by R. Y. Ferner Co., Inc. Special attention in this exhibit will be given to the various interferometer techniques for which the Vickers is well adapted. Professor S. Tolansky of the University of London has refined these methods of measuring accurately the extremely minute differences in level on a face of a natural crystal or on an overstrained metal specimen.

From Germany comes the "Reichart Universal Camera Microscope Model MeF", shown by Wm. J. Hacker & Co., Inc. The operator may observe the specimen either directly through an eyepiece or on a ground-glass screen. It is capable of magnification from 4.5 to 2200, using

Classified List of Exhibitors

Mechanical Testing Equipment

Baldwin-Lima-Hamilton Corp.—1520
Buehler, Ltd.—208
Cities Service Petroleum, Inc.—1309
Continental Tooling Service, Inc.—1027
DoAll Co.—524, 623
Ercona Corp.—920
Ferner Co., Inc., R. Y.—1123
Industrial Air Controls Div., Bendix-Westinghouse Automotive Air Brake Co.—1710
Olsen Testing Machine Co., Tinius—1419
Opplem Co., Inc.—115
Riehle Testing Machines Div., American Machine and Metals, Inc.—1239
Rodgers Hydraulic, Inc.—1558
Steel City Testing Machines, Inc.—1416
Tincher Products Co.—1975

Microscopes and Attachments

American Optical Co., Instrument Division—442
Bausch & Lomb Optical Co.—405
Buehler, Ltd.—208
Ercona Corp.—920
Ferner Co., Inc., R. Y.—1123
Griswold Mfg. Co.—1016
Hacker & Co., Inc., William J.—1279
Harshaw Scientific Div., Harshaw Chemical Co.—1420
King, Andrew—121
Opplem Co., Inc.—115
Research & Control Instruments Div., North American Philips Co., Inc.—1861
Uddeholm Co. of America, Inc.—915
Williams, Brown & Earle, Inc.—1232

Radiographic Equipment, Other Nondestructive Testing

American Cystoscope Makers, Inc.—242
Ansco Div., General Aniline & Film Corp.—929
Atomic Energy of Canada, Ltd.—1479
General Electric Co., X-Ray Dept.—1549
Jarrell-Ash Co.—1205
Keleket X-Ray Corp.—1809
Magnaflux Corp.—537
Magnetic Analysis Corp.—518
Picker X-Ray Corp.—441
Research & Control Instruments Div., North American Philips Co., Inc.—1861
Sperry Products, Inc.—1754
Superdraulic Corp.—1877
Turco Products, Inc.—1028
Westinghouse Electric Corp.—1510

Analytical Equipment and Supplies

Applied Research Labs.—1757
Baird Associates, Inc.—416
Buehler, Ltd.—208
General Chemical Div., Allied Chemical & Dye Corp.—1619
Harshaw Chemical Co.—1420
Jarrell-Ash Co.—1205
Lindberg Engineering Co.—330
National Spectrographic Labs. Corp.—1471
North American Philips Co., Inc.—1861
William, Brown & Earle, Inc.—1232

Electronic Test Accessories

Automatic Temperature Control Co., Inc.—1768
Baldwin-Lima-Hamilton Corp.—1520
Brush Development Co.—1358
Continental Tooling Service, Inc.—1027
Latrobe Steel Co.—1649
Sperry Products, Inc.—1754
Weston Electrical Instrument Corp.—1011

Physical Testing Equipment

Baldwin-Lima-Hamilton Corp.—1520
Brush Development Co.—1358
Buehler, Ltd.—208
Ferner Co., Inc., R. Y.—1123
General Electric Co., X-Ray Dept.—1549
Griswold Mfg. Co.—1016
Micrometrical Mfg. Co.—1458
Newark Wire Cloth Co.—1853
Riehle Testing Machines Div., American Machine and Metals, Inc.—1239
Steel City Testing Machines, Inc.—1416
Webber Appliance Co., Inc., Industrial Freezer Div.—1368

Gages, Comparators and Associated Devices

American Optical Co., Instrument Div.—442
Automatic Temperature Control Co., Inc.—1768
Brush Development Co.—1358
Collins Micro-Flat Co.—1281
Curtis Machine Corp.—937
DoAll Co.—524, 623
Ercona Corp.—920
Magnaflux Corp.—537
Magnetic Analysis Corp.—518
Micrometrical Mfg. Co.—1458
Opplem Co., Inc.—115
Scherr Co., Inc., George—1269
Sperry Products, Inc.—1754
Starrett Co., L. S.—1843

Hardness Testers

Buehler, Ltd.—208
DoAll Co.—524, 623
Ercona Corp.—920
Ferner Co., Inc., R. Y.—1123
Hacker & Co., Inc., William J.—1279
King, Andrew—121
Opplem Co., Inc.—115
Riehle Testing Machines Div., American Machine and Metals, Inc.—1239
Rodgers Hydraulic Inc.—1558
Steel City Testing Machines, Inc.—1416
Uddeholm Co. of America, Inc.—915
Williams, Brown & Earle, Inc.—1232
Wilson Mechanical Instrument Div., American Chain & Cable Co., Inc.—706

For descriptions of other exhibits see p. 17 e. s. and p. 274 e. s.

dark and bright ground, ordinary or polarized light. An extra attachment for microhardness testing is also available.

Two Danish pieces of equipment for electropolishing are exhibited by Uddeholm Co. of America, Inc. One, the "Disa-Electropolisher", is a small cabinet containing all electrical controls, timers, and a solution pump. It polishes and etches round or oblong spots on microspecimens. Another device, the "Micropol", will polish a spot the size of a pinhead on a complete tool or surface which needs be examined without harming the finished object.

Radiography — While radium, cobalt^{60} and iridium^{192} for radiography (the latter two a byproduct of a uranium pile) are marketed by Atomic Energy of Canada, Ltd., X-ray equipment on display at the Exposition is growing in power and adaptability. For example, Keleket X-Ray Corp. will feature its "Tubecrane", a

Model 2400P American Optical Research Desk-Type Metallograph. From start to finish every operation may be performed while sitting at the desk

system of girders near the ceiling on which a trolley moves, carrying a telescoping vertical column. At the end of the column is attached the X-ray unit by a swiveling arm so material, placed anywhere in the room at any elevation, can be examined at any angle.

A depth of 14 in. of steel can be penetrated with the massive 22,000,000-electron-volt betatron, made by Picker X-Ray Corp. Due to the small focal spot (0.005 sq.in.) and nonscattering rays, a discontinuity of 0.002 in. in the middle of a foot of metal can be picked up on the film with the aid of a hand glass. The equipment is, of course, valuable for rapid inspection of much thinner masses; time of exposure is about 1 min. for 6 in. of steel.

Surface Analyzers — Brush Development Co. will display three machines for measuring the smoothness of smooth surfaces. "Faxfilm Surface Comparator BL-122" compares a workpiece with a standard specimen. "Brush Surfindicator BL-110" is a rapid, hand-operated instrument for measuring (but not recording) surface roughness to 0.000,005 in. "Brush Surface Analyzer BL-103" is five times as sensitive, and indicates average roughness and records heights of ridges or depths of scratches instantaneously by a direct-writing oscillograph.

A shop instrument which shows on a dial the surface roughness of a part while still in the machine tool is the "Profilometer", exhibited by Micrometrical Mfg. Co. (formerly Physics Research Co.). A tracer is merely moved slowly along the work surface by hand and the needle deflection directly indicating roughness in microinches, root mean square, is either used as a "go, no-go" indicator or compared immediately with a similar stroke over a glass roughness specimen or a standard acceptable surface.

Industrial Equipment

ONE OF THE MOST important measures of economy that the materials handling industry has introduced is the practice of regarding a large number of relatively small items as a unit load which can be carried by a fork truck and tiered to conserve floor space. Castings, forgings and fabricated parts of irregular shape which cannot be stacked on ordinary pallets are easily handled in stout wire baskets such as made by Union Steel Products Co. Supporting legs of these baskets have a bearing plate to align one container above another during tiering, and to provide a secure hold on the basket on which it is stacked. The sides and ends of these baskets can be folded to conserve space during return shipment and storage.

A 12-ton capacity crane and a steel belt conveyer will be among the handling equipment on display. The crane, made by Coles Cranes, Inc., is fitted with limit switches on hoist and boom motions, with an automatic load indicator and a cut-out to prevent overloading. Steel Parts Mfg. Co. is the maker of the conveyer using belt plates of 14 or 18-gage steel for the working surface. Ends of the plates are rolled so as to provide a link when the mating curl on the adjacent plate is slipped around. These curled ends also slide on a longitudinal member of the conveyer frame or housing and keep the belt from sagging. Such a belt can be used in inclined and vertical positions, and will carry 200 lb. per sq.ft. in the horizontal position.

New and improved motors and motor drives to be displayed include General Electric Co.'s fan-cooled, high-slip motor for punch presses and Reeves Pulley Co.'s variable speed transmissions and motor pulleys (including a transparent plastic model that will show its

Three Basic Units — Channel Frame, a Spring-Backed Bolt and Locking Fittings Such as T-Plates and Angles — Can Be Assembled Into Racks, Scaffolds and Similar Frame Structures. The channels are cut to desired length and assembled with a socket wrench. Serrations on the frame secure the bolt head while fittings and nut are placed. To be exhibited by Mult-A-Frame Division of Ainsworth Mfg. Corp.

"innards"). Drives with single and double reduction gears for low-speed electric motors, a variable speed drive, as well as normal speed motors built by Sterling Electric Motors, Inc., will be on display.

In submerged arc welding and hot-topping of ingots by the electric arc, worthwhile economies can be realized by reclaiming the powdered flux, which has not been melted into a glass. Equipment for this purpose will be operated by the Invincible Vacuum Cleaner Mfg. Co. which makes these machines as well as industrial vacuum cleaners. One of the features of their flux recovery units is the separation of fused particles and fine dust from the unfused flux before it is returned to the work.

Another cleaning problem is the removal of stale or dust-laden air from the offices and factories. The turbocompressors manufactured by the Spencer Turbine Co. can be used for this purpose by operating them in a duct system which draws air out of the desired room and blows it to the outside. The compressors can move up to 20,000 cu.ft. per min. and develop pressures up to 5 psi. Such great masses of air can be moved because the air that is drawn through the intake receives a multistage build-up by the centrifugal action of the impellers.

Ajusto Equipment Co. tackles the problem of increased manufacturing efficiency from another aspect, which is to minimize fatigue in workers by providing adequate seating when they do not have to stand or move about in performing their duties. Several models of chairs and stools, which use the principle of the bicycle coaster brake for the adjustment mechanism, will be displayed by Ajusto. Another line of mill supplies that make the worker's job easier are the portable, hydraulically operated bolt and wire cutters, and the guillotine-type of cutting, punching, shearing and riveting machines to be shown by Manco Mfg. Co.

Classified List of Exhibitors

Materials Handling

American Brake Shoe Co.—130
American Brass Co.—241
Brainard Steel Div.—660
Coles Cranes, Inc.—1369
Electric Furnace Co.—341
Flexonics Corp.—534
Gray Co., Inc.—924
Heppenstall Co.—1572
Invincible Vacuum Cleaner Mfg. Co.—1256
Jensen Specialties, Inc.—1415
Mult-A-Frame Div., Ainsworth Mfg. Co.—1343
Sandvik Steel, Inc.—402
Steel-Parts Mfg. Co.—1382
Union Steel Products Co.—1216

Miscellaneous Mill Supplies and Equipment

Air Products, Inc.—1662
Ajusto Equipment Co.—1376
American Brake Shoe Co.—130
Bruning Co., Inc., Charles—1440
Distillation Products Industries (Div. of Eastman Kodak Co.)—1428
DoAll Co.—524, 623
Fawick Airflex Co., Inc.—1963
Flexonics Corp.—534
General Electric Co., Apparatus Div.—251
Globe Stamping Div., Hupp Corp.—1354
Jones Co., C. Walker—1257
Manco Mfg. Co.—1480
Parker Rust Proof Co.—1909
Peters-Dalton, Inc.—1410
Reeves Pulley Co.—1553
Schrader's Son Div., A.—1856
Snap-on Tools Corp.—1127
Spencer Turbine Co.—1942
Sterling Electric Motors, Inc.—1949
Superdraulic Corp.—1877
Taco Heaters Inc.—1829
Thomas, Kenneth F.—1567
Torit Mfg. Co.—1881
Tyler Mfg. Co.—1280
U. S. Electrical Motors, Inc.—760
United States Plywood Corp.—1282
Vapofier Corp.—1953

For descriptions of other exhibits see p. 17 e. s. and p. 274 e. s.

American Society for Metals

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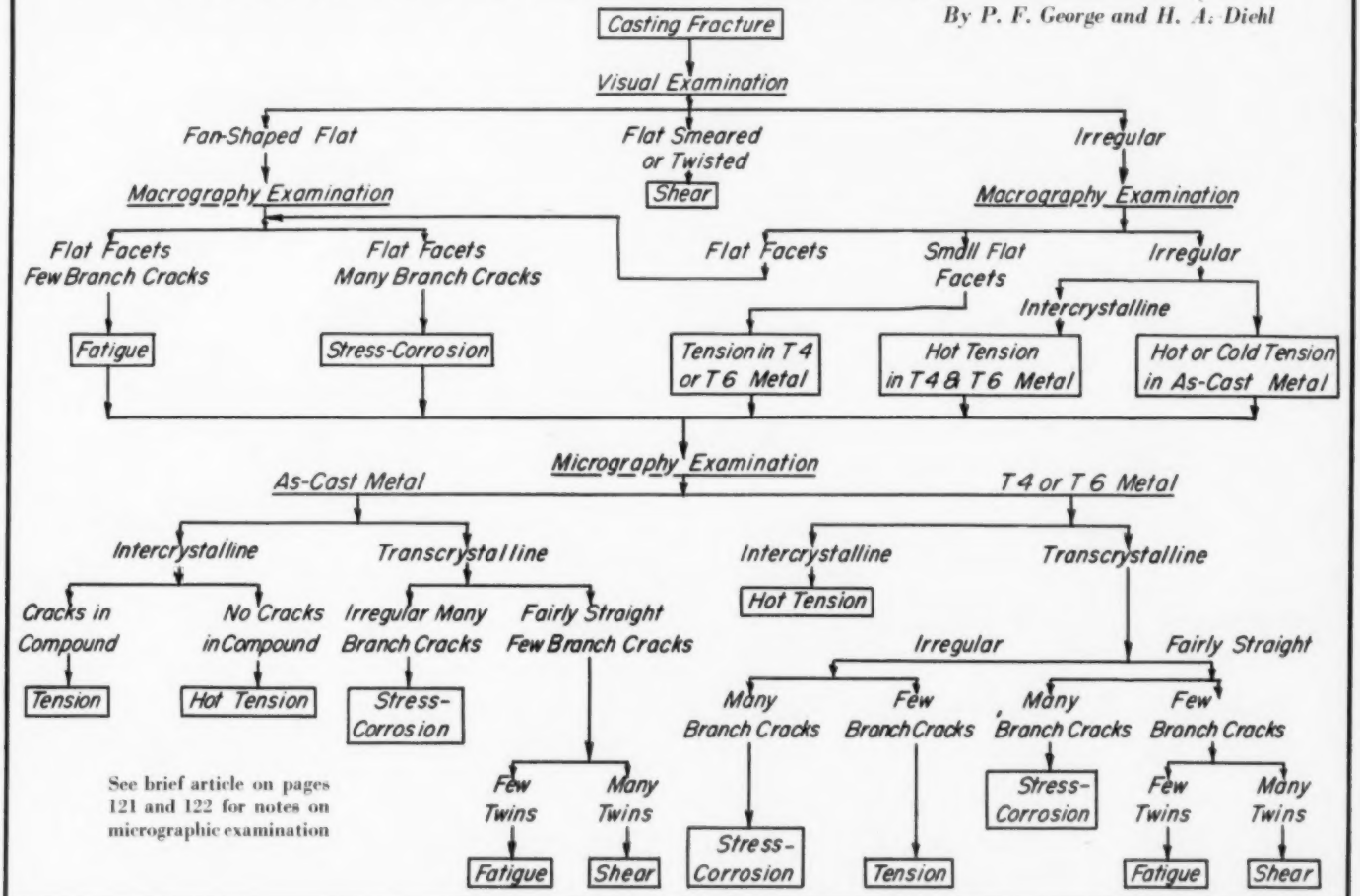
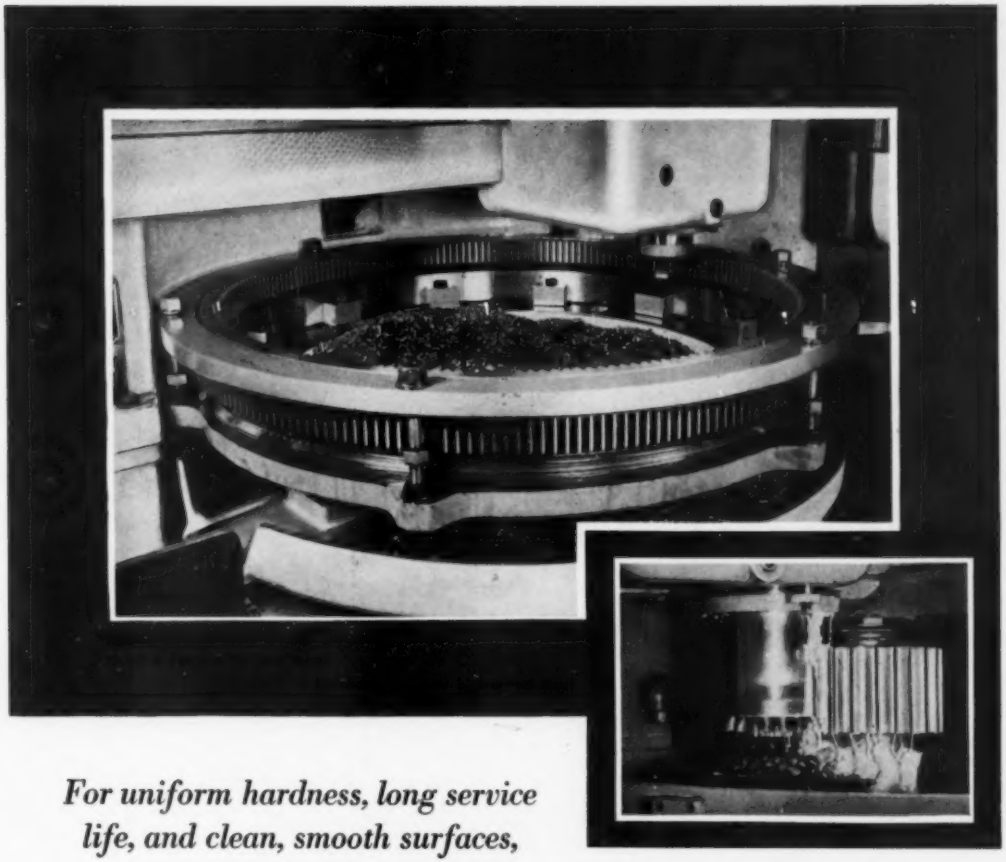
By P. F. George and H. A. Diehl



See brief article on pages 121 and 122 for notes on micrographic examination



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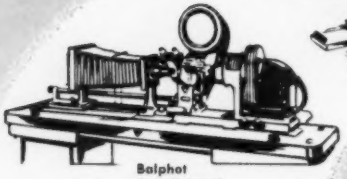
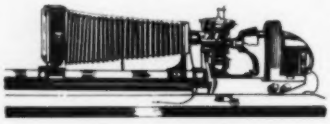
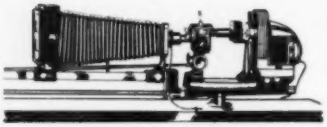


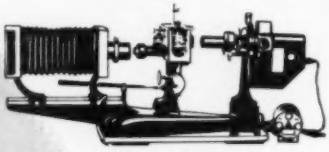
Baiphot Metallograph



Research Metallograph



ILS Metallograph



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Historical Aspects of and Conservation in Constructional Alloy Steels

By **John Mitchell**, Assistant to Manager of Alloy Sales, U. S. Steel Co., Pittsburgh

IN RETROSPECT, experiences of the past 18 months concerning conservation in constructional alloy steels* clearly indicate that approaches and measures used have not been adequate to meet present-day needs, civilian and preparedness, and would by no means suffice as a basic pattern of usage if we were suddenly called upon to expand alloy steel production. We are barely skimming through. Any increased demand in any category of alloy steel production to meet a more accelerated preparedness program would present some very perplexing problems.

It is recognized that a reasonable amount of desirable conservation has already been achieved but it has not been carried far enough to set the house in order. We must determine how the types of alloy steels (or the average weighted composition level of critical alloying elements) can be modified to permit as much as a 100% increase in constructional alloy steel production; this must be done without using any more of the critical alloying elements than are currently available.

Nickel, it appears, is and will be the most critical of the alloying elements. Obviously, if that element is scarce now, the demand will most certainly become more insistent if all alloy steel production were increased. Therefore, our discussion will be centered about the assumption that any increased production of constructional alloy steel must use no more nickel than at present — perhaps less. In dealing with such an approach, careful consideration must be given to the impact of shifting the load from nickel to molybdenum, chromium, manganese, vanadium, silicon or boron (the latter two presenting no particular problem). We must avoid creating shortages in other elements.

1951 Versus 1950 — Let us first review gains due to conservation in 1951 over 1950. The total alloy steel production for 1951 was 10,124,587 ingot tons, as shown in Fig. 1, of which 6,731,252 tons was constructional alloy steel and 3,393,335 tons other alloy steels. Constructional alloy steel was 6.4% of total ingots — a proportion slightly higher than normal periods; however, actual tonnage was about 20% more than 1950. It was this increase in *all* alloy steels (as well as new and heavy military demands) that created distribution problems in critical materials.

After World War II and through 1950, the nickel content in constructional alloy steels, Fig. 3, settled down to an average of 1.25% and the conservation effected in 1951 dropped this level to 0.90% — a reduction of 28%. While this was taking place the nickel-bearing steels in the grade mix pattern dropped from 50% in 1950 to 40% in 1951 — a decrease of 20%. (See Fig. 2.)

The effective conservation in nickel was therefore about 15,000,000 lb. for 1951. The method generally used to accomplish this was *(a)* to downgrade high-nickel steels to some lower level — for example, from A.I.S.I. 4620 (1.82% Ni) to TS8620 (0.55% Ni) — or *(b)* to change a low-nickel steel to one containing no nickel — for example, A.I.S.I. 8640 to TS4100 — or *(c)* to downgrade a higher nickel-bearing steel to one containing a lower nickel content with boron — for example, A.I.S.I. 8640 to TS81B40. By this process, some 13,000,000 lb. of nickel was removed by straight downgrading of nickel steels and about 2,000,000 lb. by downgrading to lower nickel grades containing boron.

The same general principle was used for molybdenum, *(a)* by downgrading a high-molybdenum steel — for example, A.I.S.I. 4100 to TS4100 — or *(b)* by changing

*When the words "alloy steels" are used in this discussion, they apply only to that category known as "constructional alloy steels", a term applied to regular A.I.S.I.-S.A.E. basic types of alloy steels which contain less than 4% chromium. Unless specifically referred to, "alloy steels" will *not* cover other categories of alloy steels such as high-strength steels, silicon electrical sheet, toolsteels, heat or corrosion resisting stainless steels, and cast alloy steels.

to some steel containing no critical elements — some with boron, like 50B40. These efforts conserved some 7,000,000 lb. of molybdenum, of which 6,500,000 lb. was conserved by straight downgrading and about 500,000 lb. by using boron steels.

As a result of both approaches, the boron steels accounted for 5% of the total constructional alloy steel production in 1951, a figure about the same as reached during World War II. (See Fig. 2.) From present indications the boron steels will probably reach 8 or 9% during 1952.

While this was going on, the American steel producers were able to secure 13% of the required nickel from consumer-generated scrap and 30% from mill scrap — a total of 43%. As to molybdenum, 10% was recovered from consumer-generated scrap and 20% from mill scrap — a total of 30%. Even with these practices, losses of nickel in unidentifiable scrap or scrap which became mixed or dissipated in other nonalloy steel was about 5,000,000 lb. of nickel and 1,000,000 lb. of molybdenum.

During the past 52 years the production of constructional alloy steels over an extended normal production period approximates about 5 to 6% of total ingot production. This is shown in Fig. 1. This constant relationship makes it simple to forecast the future *normal* production rates. From the historical patterns of the various types of alloy steels it is also possible to calculate the probable demands upon critical raw materials.

In contrast to this peacetime relationship, during World War II the percentage of constructional alloy steel ingots rose to 11.2% of the total of 88,000,000 tons. With provision to increase over-all steel mill capacity to about 118,000,000 ingot-tons, it is apparent that if we were again called upon to meet full mobilization demands in the same proportions as during World War II, constructional alloy steel production could increase to as much as 13,000,000 ingot-tons and *total* alloy steel to as much as 17,000,000 to 20,000,000 ingot-tons. This would mean a 100% increase over the 1951 production rate, and a 42% increase over alloy steel production in World War II.

We have already, in 1952, experienced difficulties in properly distributing the important alloying elements — particularly nickel and to a lesser degree molybdenum — even though the current production rate is about half the estimated maximum. So the question arises, "What would we have to do if we had to double these production figures?" The combined information presented in Fig. 2 and 3 represents basic trends which may serve as a guide to the permissible usage when the supply of alloying elements must be closely controlled or prorated to balance supply and demand.

In Fig. 3, it will be noted that changes also occur during normal periods (incidentally, in the direction of more economical use of alloying elements). Peacetime changes in either element levels or in the types of steels can be attributed generally to

A. Advancements in the art and science of metallurgy leading to better understanding of properties required to make satisfactory parts.

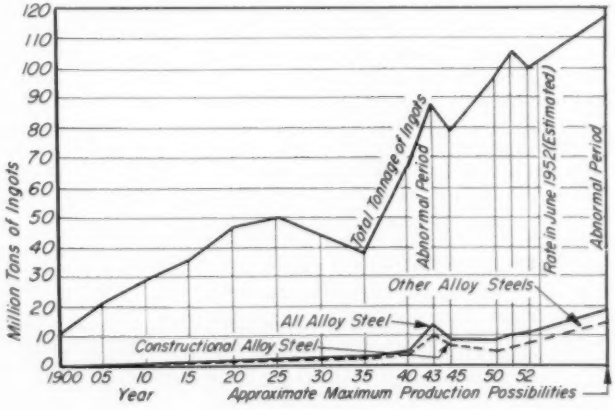
B. The effort to economize in raw material.

C. Advancement in design and engineering principles.

D. The introduction and use of molybdenum.

E. Introduction and use of boron.

Fig. 1 — Record of Steel Production in the United States. Normally, constructional alloy steels represent about 5.5% of total ingots. However, in abnormal periods, as noted, this may increase to 11 or 12%, which is considered the approximate maximum capacity when balanced with other steel demands



F. Knowledge gained about the actual requirements of military uses.

G. Constant over-all effort to improve performance of parts by improving heat treating technique to obtain maximum mechanical properties with the minimum amounts of alloying elements.

Figures 1, 2 and 3, as well as knowledge about the relative supply, enable us to estimate, as in Fig. 4, the levels of elements involved and the permissible percentage of basic types to which alloy steels would have to be restricted if production increased from the present level of 6,700,000 tons to an estimated maximum of 13,000,000 ingot-tons. If production were increased even further, the curves would be extended proportionately.

Necessary Trend of Alloy Content

The reasons for using the specific combinations shown in Fig. 4 (although they could be adjusted without affecting or throwing out of balance the total demand) are as follows:

1. Proportionate usage or "pattern" follows closely trends of experience of the past.
2. The pattern appears reasonable in view of experience with performance in representative applications.
3. The pattern will fit the complications that will arise in recovery of elements from scrap.
4. Economical combinations can be selected within the pattern.
5. Such steels can be manufactured by all steel producers with the fewest complications.
6. Combinations can be devised in these proportions to meet the hardenability required with the least amount of load thrown upon some other important element.
7. Combinations can be selected to include a certain amount of basic grades containing the most critical elements, for those applications where the functional purpose of the element is known to be an absolute requirement.

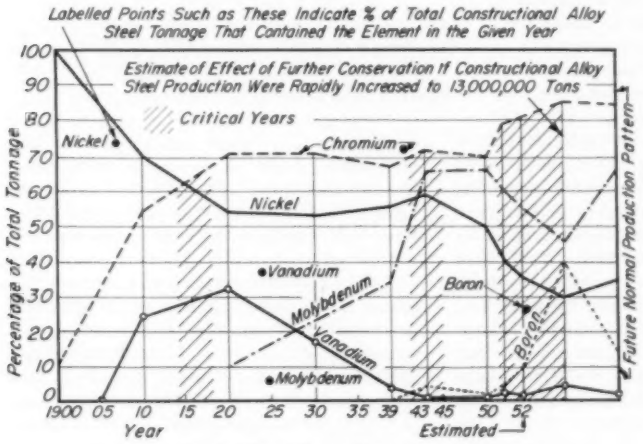


Fig. 2 — Grade Mix of Types Since 1900. Lines represent percentage of total tonnage of constructional alloy steels that contains the element shown. Totals are over 100% (in 1920, for example, Cr 71%, Ni 54%, V 32%, Mo 10%, total 167%) because many popular steels contain more than one alloy

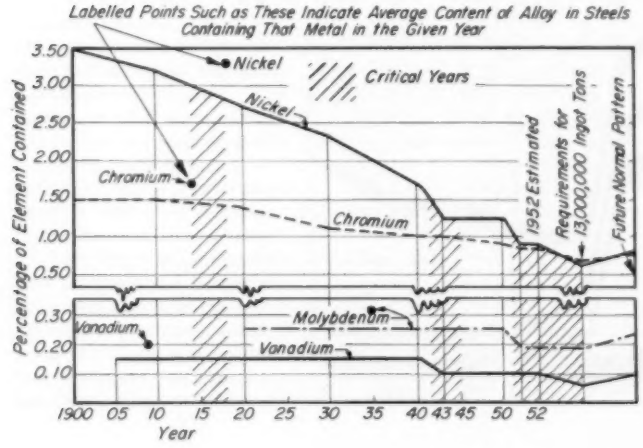


Fig. 3 — Trend of Alloy Consumption in Constructional Alloy Steels and Estimates of Alloy Needs if We Had to Make 13,000,000 Ingot-Tons Immediately. A predicted normal pattern for the not-distant future is indicated at the right end

If the steel-type and element-level patterns shown at 13,000,000 ingot-tons of constructional alloy steels in Fig. 4 were applied to practice, the increased loads upon all elements involved would be about as follows:

Nickel	No change
Manganese	Plus 70%
Chromium	Plus 60%
Molybdenum	Plus 57%
Vanadium	Plus 180%
Boron	Plus 670%

Analysis of 52-Year Trend

In no case, however, would the load be doubled on the first four elements, as would be true if present established steel types were doubled in production. (Demands would then increase 100% except for vanadium and boron.) This indicates how serious the situation could become if we fail to recognize it now and make the necessary compensating moves to circumvent problems later.

The composite pattern for 52 years is shown in Fig. 5; also shown are the changes contemplated if alloy steel production were increased to 13,000,000 tons. These data reveal that, up to time of World War I, Cr-Ni and Cr-V steels were replacing the almost omnipresent nickel steels. Chromium steels and molybdenum-containing steels introduced during or after that period became more popular between 1920 and 1940. World War II caused the pattern to change abruptly to conform to the supply of raw material and scrap; hence the sudden switch to large quantities of Cr-Ni-Mo steels. Since that time and through 1950 a readjustment caused the nickel-molybdenum, chromium-molybdenum, straight molybdenum and chromium steels to be again adopted in greater quantities. The pattern that shaped up during 1946 to 1950 seemed generally to have followed raw material economics — a natural effect.

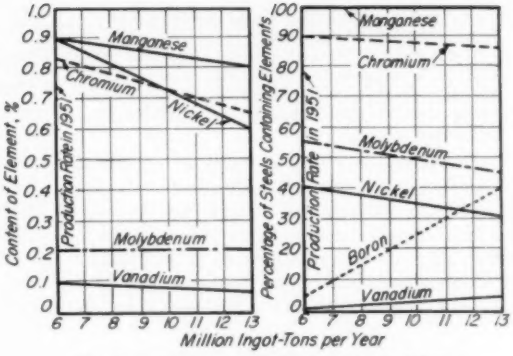
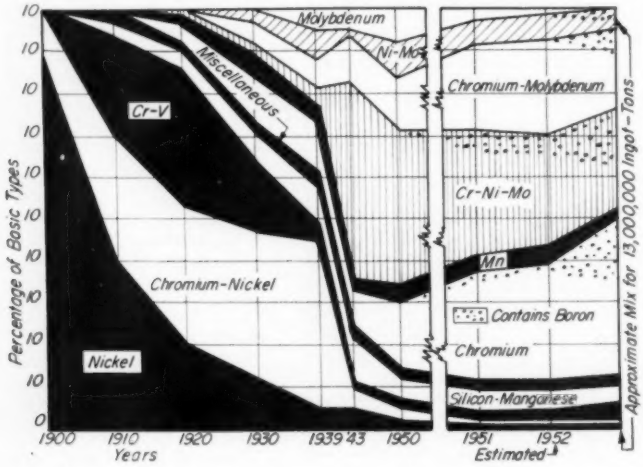


Fig. 4 — (Left) Necessary Trend of Alloy Content in Constructional Steels as Total Annual Tonnage Increases. (Right) Proportion of steels containing the various elements in order to meet the same requirement

When in 1950 conservation became necessary again, the same general approach used during World War II was adopted — namely, the use of low Cr-Ni-Mo combinations, with or without boron. It was assumed that the recovery of alloying elements from scrap, the supply of alloying elements, and other considerations would approximate conditions of World War II. We lacked proper information on the supply of alloys which would provide for a divided program, civilian demands on the one hand and the military needs on the other.

The past 18 months' experience of these conditions now enables us to forecast with a greater degree of accuracy what might be expected in the future, whether the preparedness program is extended or whether we return to normal civilian demands. All this emphasizes the fact that an unusual period or future peacetime planning will have to fit the raw material

Fig. 5 — Historic Record of Change in Usage of Basic Types of Constructional Alloy Steel Since 1900, and the Probable Grade Mix if Production Were to Be Increased to 13,000,000 Ingot Tons Without Arrival of Large New Sources of Alloying Elements



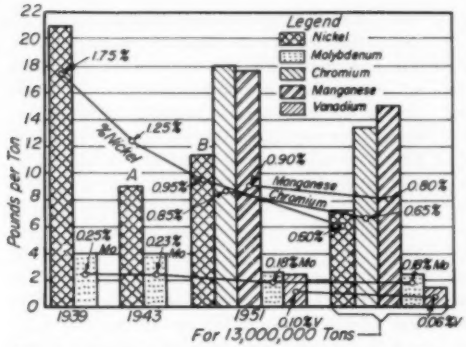


Fig. 6 — Bars Represent Amount of Alloy in Elements Required to Melt the Constructional Alloy Steels Produced in Various Years. Bars at right represent probable conditions if production were increased to 13,000,000 tons in the near future. Lines and associated figures represent percentage of element in the respective steels as shipped

supply situation more closely; usage must be directed to conform to the raw material situation. There is no other alternative. This is a departure from past experience, and it becomes more and more necessary as production of alloy steel increases. (These trends are indicated in several of the graphs already discussed, as well as in the pattern outlined in Fig. 5.)

Percentages are valuable in showing trends, but figures showing actual consumption of alloys in engineering steels cannot be computed until you know how many tons are made and how much alloy is used in an average ton. To help take this next step, and bearing in mind that some alloy can be recovered from scrap, Fig. 6 was prepared. It shows the pounds of new elements needed (left-hand scale) to make a ton of alloy steel in the respective grades. Of particular significance is the difference in amount of alloy absorbed by the steel industry, as illustrated in the height of columns A for nickel in 1943 and B for 1951 in relation to the amount of the element appearing in the finished steel (trend line and figures). In 1943 there was a 63% recovery of nickel from scrap, but in 1951 only 43% of the nickel was secured from this source. In the author's opinion, this is a critical turning point — as will be explained later — that will greatly influence future distribution of alloy steel types, particularly if alloy steel production is rapidly expanded.

We will now deal with the matter of scrap containing nickel and molybdenum

Influence of Scrap Situation

and its influence upon the entire situation. The purpose of this discussion is to point out differences between past and present thinking and to show that past conditions do not prevail today, nor would they prevail if production had to be increased over today's rates.

For example, during World War II, there was sufficient nickel, chromium and molybdenum to permit us to formulate and produce a large tonnage of steels containing those elements at levels of about 0.50%, 0.50%, and 0.20% respectively. Nickel in the nickel-bearing scrap in 1940 averaged 1.75%; molybdenum was about 0.25% in molybdenum-bearing steels. Either of these had a monetary value in scrap, and this served as added incentive to scrap generators, scrap handlers or dealers to separate it properly. By various processes and ingenious methods used by steel producers in 1943, 63% of the nickel required to make nickel-bearing constructional alloy steels was recovered from scrap. Molybdenum followed along in much the same manner, though not in the same proportions, principally because efforts were primarily focused upon nickel. We ended the war with 1.25% average nickel in 55% of the constructional alloy steels made and 0.25% average molybdenum in 66% of the steels. (See Fig. 2 and 3.) These conditions matched the raw material supply at the time and permitted the establishment of the "National Emergency" steels. They were correlated with demands for alloying metals in other applications, so as to balance demand and supply.

When we started on the present program, the approach was along the same general line — namely, rely heavily on Cr-Ni-Mo steels carrying the old relative amounts — 2½ parts nickel, 2½ parts chromium, and 1 part molybdenum (with or without boron) but at the lower levels of 0.30, 0.30, and 0.12% respectively. It was assumed that elements would be available in those proportions and that recovery from scrap would be enhanced by lowering the level of elements in the finished steels. It was also assumed that recovery of elements from scrap would be comparable with the 1943 performance when scrap yielded 63% of the necessary nickel (Fig. 6).

The facts do not support this assump-

Law of Diminishing Returns

tion. Only 43% is now recovered. A large percentage of Cr-Ni-Mo steels cannot be manufactured even in these low ratios because the raw material supply and other demands have changed from those of World War II. The basic combinations, whenever permitted for use in 1952, are generally satisfactory, but the quantity that could be permitted would have to be decreased (see Fig. 5) if constructional alloy steel production were increased over present levels. We have now reached the point where the small amounts of alloy required to make the lean steels, even though a reasonable recovery is made from scrap, is becoming just as important as the higher quantities to make richer steels during the last war.

For the first time in our history the average nickel content of constructional alloy steels has fallen below 1.00%. This is the point where nickel contained in scrap ceases to bring scrap generators or scrap dealers a premium for separating it. Steel manufacturers interested in conservation have therefore prevailed upon those responsible for maintaining controls to relax present procedures and permit scrap-purchasing methods at levels of 0.50% min. nickel rather than 1.00% minimum.

Although it will help some, even this action will not insure proper identification or segregation of nickel-bearing scrap, particularly when considerable tonnage now produced contains less than 0.50%. The same may be said for molybdenum for which no premium can be expected below 0.15% min., which is also above the average level of many steels now manufactured. This is where the commercial methods and limitations of scrap handling differ with some of the past philosophy, and as a result it is beginning to make itself felt in the performance contrasted at points A and B in Fig. 6.

Though this discussion barely scratches the surface of the scrap problem, it tends to reveal the falsity of any hopes based upon continued high recoveries from scrap. The law of diminishing returns is rapidly making itself felt; the result is that the lower the average level of elements in steels, the greater the percentage of new or virgin element will be needed to make a given composition. Thus, anticipated recovery from scrap cannot be realized.

This situation would be of no consequence if there were sufficient amounts of the elements to go around without depending upon high recovery from scrap. This not being true, it appears that present patterns of usage cannot be retained if alloy steel production were to increase. The picture becomes even darker when it is remembered that the lines in Fig. 4 are based on present scrap recoveries, and these will not hold as composition levels are lowered. Eventually, when levels settle at some lower average content and fewer of these steels containing critical elements exist among the constructional alloy steels, about all that can be expected will be that portion of elements recoverable *at* the mill *from* mill scrap — perhaps 25%. When this occurs, for example, a steel containing 0.30% nickel will require as much new nickel as a steel now containing 0.40% nickel — since recovery of nickel from scrap will have dropped from the current 43% to about 25%.

Fig. 7 — Nickel Residual in Openhearth Heats During Representative Recent Periods (A.I.S.I. Data)

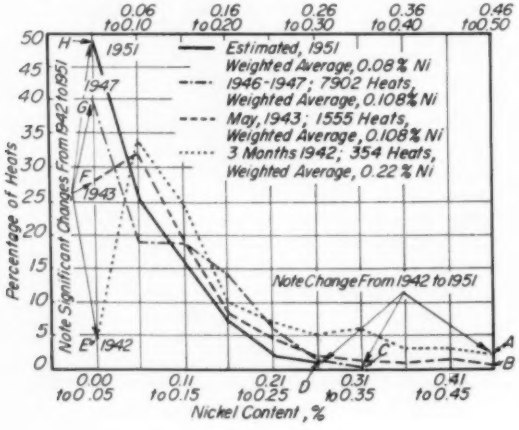


Figure 7 substantiates this trend with respect to nickel. For example, note the difference in residual nickel between 1942 and 1943 and the estimates of 1947 and today — at points A and B to C and D — a recession which corresponds to the drop of average nickel content in nickel steels shown in Fig. 2. Also note the increasing number of heats containing very low residuals — points E to F and G to H in Fig. 7. The same relative shift is taking place in molybdenum. The high residuals which prevailed during

World War II are disappearing with the result that, as time goes on, more new element (nickel or molybdenum) will be needed to make a given composition.

During the current study of the scrap situation, it was found that if all consumer-generated scrap were mixed with sufficient nickel-free scrap to make constructional alloy steels, the resultant contamination in the steel produced, at its worst, could be no more than 0.08%. If all mill-revert scrap containing nickel were mixed in the same manner, the residual would be 0.12% nickel. If both were mixed in the same manner, the result would be 0.20%.

To illustrate further, a recent study of demands upon nickel in constructional alloy steels revealed that about 70% of it comes from those steels containing 1.00% or more of nickel; however, the tonnage in those steels is comparatively low. These may be termed "must" applications under present conditions, and they would be so considered if production were increased. To the author this means that if a percentage for "must" applications is to be produced, the only place from which the nickel could come would be from the low-nickel steels (particularly those containing over 0.30% carbon wherein there is a question of whether nickel serves a functional purpose). The only alternative would be to reduce the amount of nickel permitted in "must" applications. Obviously, changes in both categories would have to be made.

If the total nickel demand were held to the present level, then these changes would have to occur so as to conform to the pattern of Fig. 4* (even though some 5,000,000 lb. of nickel in mixed scrap would be lost). If, however, alloy steel production were increased to some 13,000,000 tons and the critical elements in the grade mix were *not* changed in line with Fig. 4, then the over-all nickel demand would double and losses in scrap could reach 10,000,000 lb. annually — perhaps more, because of the amount of steels made with very low nickel. This, we are certain, could not be permitted.

The above illustrates what would happen to a lesser degree to other scarce elements, as well. At any rate, the average weighted level of elements and the types of constructional alloy steels would have to be modified to conform to supply.

It seems *apropos* to mention the fact that many of the data and ideas presented here were anticipated at the end of World War II when H-steels were established to offset the effects of some unavoidable contamination of nickel, molybdenum and chromium. They seemed to be most logical, not only to cope with any future problem in residuals but also to produce steels with desirable uniformity in response to heat treatment. The same techniques will provide the means by which steels of uniform hardenability can be produced, concurrent with handling the residual problem of the future.

Meeting Increased Production Rates

SUMMARY AND RECOMMENDATIONS

1. In summarizing the situation it may be said that we have by no means reached the proper levels of alloying elements in our common steels nor the distribution of types that would be required to meet an increased production rate.

2. When we reach the objectives set forth at the right-hand end of the lines in Fig. 4 (13,000,000 ingot-tons of alloy steels annually) we will have reached the limits of conservation in this category of alloy steels, unless sacrifices can be made in product performance — most improbable — or unless we resort to extensive redesign. If the elements were reduced much beyond those levels shown at the right of Fig. 4, the matter of maintaining required hardenability will be most difficult until further research in alloy steels uncovers the possibilities of elements not now commonly used.

3. The job of conservation can be enhanced still further by making use of steels that contain little or no critical elements, with or without boron, without imposing undue loads upon other elements beyond their supply — even if production of constructional alloy ingots were to increase to 13,000,000 tons.

4. The objectives set forth in Fig. 4, not only with regard to nickel but also manganese, chromium, molybdenum, vanadium, or boron, are not out of line with the trends.

5. Conservation, to date, has been partially effective but would represent only the half-way mark if alloy steel production

(Continued on p. 144)

*For 1951, 6,000,000 ingot tons × 41% × 0.90% Ni = 22,140 tons of nickel. For maximum alloy steel production, 13,000,000 ingot tons × 31% × 0.60% Ni = 23,400 tons of nickel. — EDITOR'S FOOTNOTE.

Courtesy Norton Co.

Abrasive Tumbling Gives Precision Finishes Economically

METAL ENGINEERS concerned with rising costs for finishing metal products should determine if they are taking full advantage of the advances which have been made in precision barrel tumbling. One logical approach to economies in the preparation of surfaces for finishing is to handle them in bulk rather than individually. Any handling of individual parts — hand filing or scraping, bench or portable grinding — should be scrutinized carefully as to unit cost.

In outlining the possibilities of abrasive tumbling before the 37th Annual Convention of the American Electroplaters' Society, Hubert M. Goldman of Enthone, Inc., pointed out that the process can be used in its roughest form for the removal of "skin", scale and fins from castings, and scale from forgings. A more carefully controlled operation will remove flash and burrs, edges, rough spots, scale and rust, and will cut down a metal surface to a uniform condition. Both operations will effectively blend in chamfers and formed radii or will round off corners and sharp edges. Still finer control can result in considerable improvement in surface finish as measured in micro-inches or judged by "color" or appearance; abrasive tumbling thereupon approaches true burnishing.

Efficient deburring of precision parts by tumbling rather than by hand methods is becoming of increasing importance to automotive, aircraft, and other manufacturers of precision metal parts. Close fits and good finish are important for transmission parts. While regular machining leaves burr-free edges on some components, others must undergo further finishing operations before they can be assembled into a housing. It is reported in *American Machinist* (April 16, 1951) that Chevrolet uses abrasive wet tumbling to deburr edges and improve surface finish on a dozen different parts for its "power-glide" transmission.

By Allen G. Gray
Consulting Editor to Metal Progress

At its new automatic transmission plant Ford Motor Co. uses wet tumbling in a rubber-lined Roto-Finish barrel to deburr precision machined parts, according to an article in *Tooling and Production* (November 1951). Furthermore, abrasive-tumbling methods for removing burrs on automatic transmission parts at the Warner Gear Div. of the Borg-Warner Corp., are described in *Automotive Industries* (Nov. 1, 1951). Burrs are removed not only from steel parts, including some stamped and some made from bar stock, but also from nonferrous parts, some of which are die-cast aluminum. Many of these parts have been completely machined, including grinding, and it is essential that burrs be taken off without breaking or marring sharp edges and that machined surfaces remain unaffected. As a matter of fact, modern wet-tumbling methods avoid the damaging effects once associated with tumbling. Figure 1 shows miscellaneous gears that have been tumble-finished by the "Roto-Finish" method.

Parts of several hundred different designs, totaling more than a million a week, are processed through the tumbling department of the Bendix Products Div. of Bendix Aviation Corp., according to Robert H. Anderson, foreman of the tumbling department, in *Iron Age* for Nov. 30, 1950. Tumbling not only removes burrs but also ball burnishes the surfaces — the latter commonly as preparation for plating. Parts processed include castings in zinc, aluminum and magnesium alloys and a great many in wrought steel. In this group are parts weighing from less than 1 oz. to as much as 15 lb. Their dimensions, likewise, range from a fraction of an inch to as much as 24 in. The parts ultimately go into such products as carburetors, brakes and a wide variety of aircraft components.

Factors to Be Considered in Barrel Finishing — According to recommendations of the Norton Co., which manufactures Alundum, an aluminum oxide abrasive for tumble finishing, the following factors should be considered before any job is processed by barrel finishing:

Requirements for Tumble Finishing

1. Size and Shape of Parts — Consider any existing recesses, angles, fillets, slots, holes, blind holes, and intricate contours in selecting the grain size or mixture of sizes which will not wedge in the work.

2. Kind of Metal and Its Hardness — Check the kind of metal, if ferrous or nonferrous, and if in the soft or hard state, as a basis for selecting the proper cleaner.

3. Size of Burr — Normal and accessible burrs can be removed whether in the soft, pickled, or hard state. Best results are obtained when parts are in the hard state. Generally, tumbling methods will not replace a rough grinding operation to remove extra-heavy burrs or burrs in concealed or hard-to-get-at places.

4. Finish Required — Check blueprint or finish requirements to select grit size, cleaner and barrel speed.

Fig. 1 — Aircraft Gears Tumble-Finished by the Roto-Finish Method

Various Types of Barrels Used

5. Quantity to be Processed — Maximum work load for the tumbling barrel will have to be determined by experimental test runs for each part.

6. Tumbling Equipment — Check the available equipment to be sure it will meet the requirements of the various parts to be processed.

The four essentials for abrasive barrel finishing are the barrel, abrasive, cleaner and water. Several different types of barrels can be used. Probably the most common type is the horizontal, octagonal-type barrel varying in size and in load capacity from one to six compartments. For continuous production runs, single-compartment and individually driven barrels may be preferable to multi-compartment barrels, since fewer stoppages will result from unloading and reloading separate compartments, and also breakdowns of the machine are minimized. The proper size of barrel depends chiefly upon the volume of work to be processed. For general shop work, 30-in. diameter is popular. The barrel should be lined and equipped with a variable-speed drive.

The so-called triple-action tumbling barrel has a special shape with pyramidal ends which gives it a fast deburring and cutting-down action. Figure 2 shows a submerged-type barrel-finishing unit. The drum is loaded with work and abrasive chips or metal shapes. This method is proving useful in the processing of heavy parts and large soft-metal parts. The cushioning effect resulting from the complete submersion of the cylinder in the tank lessens the impact to such an extent that nicking and scratching of the workpieces are kept to a minimum.

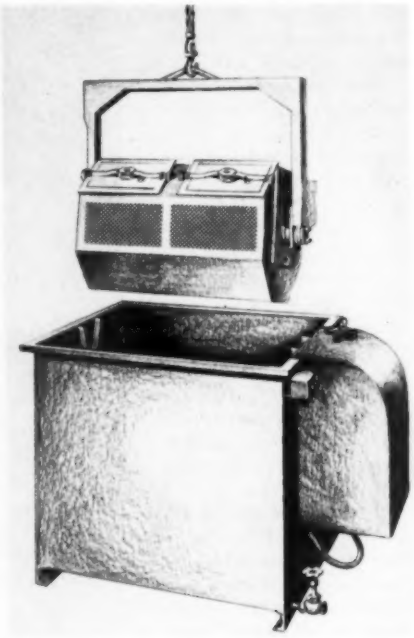
There are small bench-type and portable barrels designed for small parts, or for low-volume work. These may also be used for laboratory experimental work to test the reaction of various chemicals. The conventional tilted barrel commonly used for burnishing or drying parts is also being used for abrasive tumbling; it should preferably be of fairly large diameter and capable of being tilted to a nearly horizontal position. A variety of parts finished by Alundum abrasive tumbling is shown in the illustration at the top of page 104.

Cleaners for use in tumbling operations should be selected according to the metal and alloy being tumbled, and for the particular requirements of the operation. For instance, in rough operations a nonlubricant cleaner is recommended; for finishing operations, a lubricant cleaner (burnishing type) may be preferred. The cleaner may be acid, alkali, or neutral, according to the color requirements. For ferrous parts, the cleaner should contain a rust preventive.

DETERMINING CYCLES FOR TUMBLE FINISH

For the first trial run to determine the roughing procedure, the Norton Co. recommends that the barrel be filled with its tumbling abrasive to a point level with the top of the center shaft of the barrel. Then water is added until the water level is approximately 3 in. below the level of the abrasive. Workpieces should be added until the barrel is five-eighths to three-fourths full. If there are not enough workpieces to fill, an equal volume of abrasive should be substituted to bring the barrel load to the desired level. The appropriate cleaning compound is added

Fig. 2 — Submerged-Type Barrel-Finishing Unit. Perforated drum rotates in open tank of liquid, which provides cushioning effect in processing of soft-metal parts. (Courtesy Almco Div., Queen Stove Works)



in the amount of 2 to 8 oz. maximum for each 30x30-in. compartment.

The barrel should usually be run between 5 and 20 rpm. The optimum time cycle is determined by trial; however, lower speeds are best for removal of extra-heavy burrs. After about one hour the work should be inspected, since burrs will usually be sufficiently ground off so the speed can be increased for the rest of the roughing operation (in the interest of cutting down work time). Thereafter, the work should be inspected approximately every 30 to 60 min. until the desired results have been obtained.

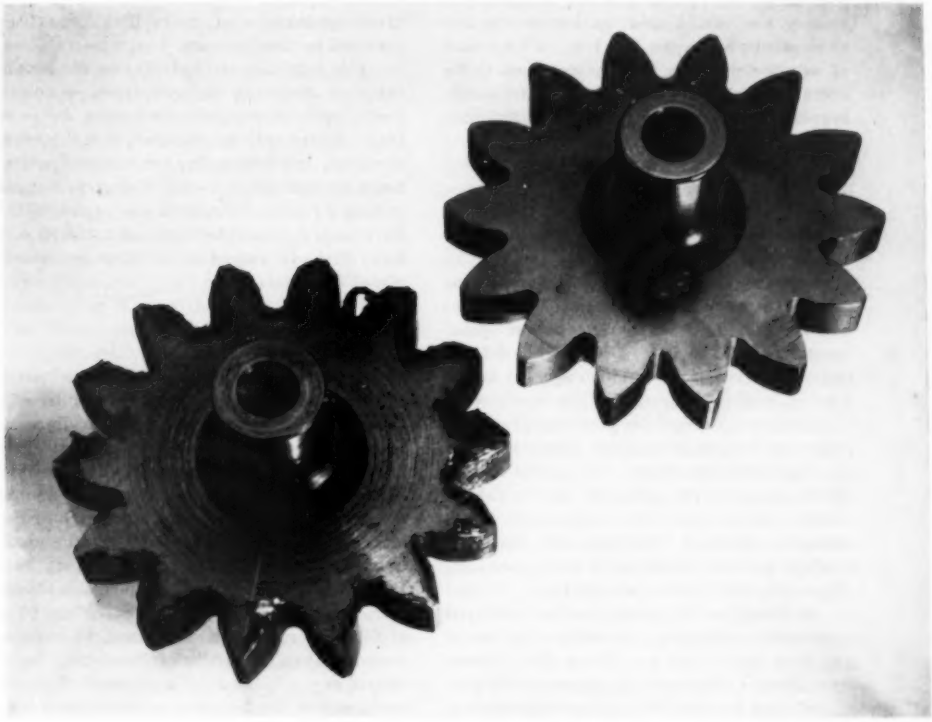
The time required to establish these results becomes a standard for the operation. On succeeding trial runs, the quantity of work added to the barrel should be increased by one tote pan and the abrasive decreased by the same amount, the load being tumbled for the standard time. These changes should be continued until the standard time no longer is sufficient to produce the desired results. The maximum amount of parts that can be cleaned in standard time then becomes the maximum work load.

Determining Maximum Work Load

Sometimes it may be desirable to use a different abrasive compound for the finishing operation. The objective here is to cause the abrasive to burnish rather than grind. For some operations, the quality of finish improves with increased barrel speed. Conventional barrels may be run as high as 35 rpm. and the submerged type up to 70 rpm. The exact time required for this operation is also determined by trial.

Figure 3 shows hardened gears before and after barrel tumbling to remove scale, deburr, and to form to 0.015-in. radius. These parts were finished in a horizontal, octagonal-type, lined barrel, the size of each compartment being 30 in. diameter and 28 in. in

Fig. 3 — Before and After Appearance of Hardened Gear Tumbled to Remove Heat Treat Scale and to Form 0.015-In. Radius. (Courtesy Norton Co.)



length. Alundum tumbling abrasive, sizes No. 2-T and 8-T, was used for roughing; No. 14-T abrasive was used for finishing. 600 lb. of No. 2-T and 300 lb. of No. 8-T were used per compartment for roughing, and 800 lb. of No. 14-T was used for finishing. For roughing, water was added until the level was approximately 3 in. below the level of the charge. For finishing, the water level was maintained approximately 10 in. above the charge. In the roughing operation, a barrel speed of 12 rpm. for one hour was used, and finishing was done at 8 rpm. for 15 min. After the initial roughing operation and before finish tumbling, the load was rinsed thoroughly. Water was added to approximately the same level as for roughing; also ½ lb. of suitable cutting-type cleaner was added, and the barrel was run at a speed of 12 rpm. for 5 hr. One pound of suitable acid-type cleaner was used in the initial roughing operation and, in the finishing operation, 2 lb. of a suitable finishing cleaner was added.

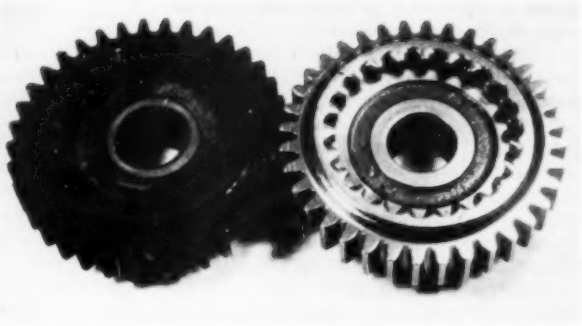


Fig. 4 — Before and After Appearance of Parts Tumbled by the Supersheen Process

TUMBLING PROCESSES

One series of engineered tumbling systems is known commercially as "Roto-Finish". Basically, these processes employ wet mixtures of specially developed chips and compound. Four basic types of operations are performed: *(a)* grinding, deburring, and descaling; *(b)* polishing; *(c)* bright honing, and *(d)* coloring. The machine in which these processes are performed is essentially an octagonal cylinder which operates in a horizontal position. The tumbling machines are generally arranged side by side in a line. An overhead handling system and a specially designed hoist pan are used for loading and unloading parts and processing chips in a Roto-Finish installation.

A precision tumbling method using a combination of chips, compounds, and water has been developed by Almco Div., Queen Stove Works. The process, known as "Supersheen" can be used for deburring, cutting-down, finishing to fineness or for coloring of ferrous or nonferrous parts. It is reported that the process may be held to within 0.0002-in. tolerances. In tumbling operations on gear-tooth surfaces, the surface approaches run-in condition and the absence of loose particles prevents oil contamination. Precision tumbling also improves the finish on threaded parts. Figure 4 shows before and after appearance of parts that have been tumbled by this process.

Dry tumbling methods have some advantages in finishing certain types of metal parts, such as zinc and aluminum die castings. Edges may be radiused or light burrs removed, but heavy fins or large imperfections are not affected except after prolonged cutting cycles. Aluminum die castings that have been dry tumbled develop polished surfaces that are almost as brilliant as electroplated finishes.

BALL BURNISHING

Ball burnishing is used to produce a bright finish on parts that already have a clean, smooth surface; it is not an abrasive operation and will not remove burrs. The process will produce a bright luster on either plated or unplated parts. According to the Abbott Ball Co., burnishing results from the pressure of steel balls rolling over the parts in a solution of soap and water. The vertical-type barrel, rather than the horizontal-type, is the correct one to use for more than 90% of all ball burnishing applications. In general, from two to three parts of burnishing balls by volume are used to each part of work processed in the barrel.

Sources and Identifying Symbols of Government Specifications

By Sherman F. Booth, Testing and Specifications Section, National Bureau of Standards

DIFFERENT AGENCIES of the Federal Government have issued many thousand specifications. These documents are the basis upon which contracts for supplies and services amounting to billions of dollars are awarded annually, both by the Government and by many other purchasers who voluntarily employ government specifications. Thus these specifications are of great importance to manufacturers, distributors, contractors, and buyers. Frequently, persons are understandably confused by the bewildering number and variety of these specifications, particularly when they want to obtain copies of specifications that are identified only by symbols. This article is intended to lessen this confusion by listing the principal sources from which specifications may be obtained and by describing the identifying symbols used by the different agencies.

There is at present no central source in the Federal Government from which the specifications used by all the different agencies may be obtained. It would be very difficult to maintain a complete or up-to-date listing or stock of such specifications because of the frequency with which they are modified or revised to meet the changing needs of the vast government procurement program.

Government specifications originate as documents of departments, bureaus and other agencies. They also originate through cooperation of all agencies working together. The latter are called Federal Specifications.

Over 2000 specifications appear in the group designated as Federal Specifications. These specifications are the highest genera of government specifications because they are developed for and coordinated by all government agencies for their use in purchasing. For the most part, they describe products and commodities which are better known and purchased more or less regularly —as opposed to commodities and products which are essential only to the needs of specialized activities. After coordination with all federal agencies, Federal Specifications are promulgated by the Administrator, General Services Administration, and their use is mandatory upon federal agencies for the purchase of the products covered thereby.

The next group of government specifications in the order of widest use is called "Departmental Specifications". Each specification in this group was developed by a department (such as Defense, Commerce and Agriculture) or an administration, for its own use. The commodity or product covered in each is usually peculiar to the specific activities of the department which developed it, and also represents a product for which a federal specification has not been prepared.

Next, in the order of widest use in the Government are "Bureau Specifications". This group usually includes all specifications developed by government agencies which do not have the stature of a department or an administration, and they are usually units smaller than departments or administrations. Generally, these consist of the lesser known specifications, although some become quite popular. They are often thought of as being temporary, or as "interim" until they have undergone a seasoning period.

Whenever departmental specifications acquire popularity in use by other government departments, it is the usual practice to graduate them to the status of a federal specification. Bureau specifications may attain departmental status or higher. However, they are used only rarely by other than the bureau or agency which developed them.

Thus, with the several departments and major government establishments and administrations, plus the many bureaus and other organizational units attached to each, there are many potential sources of specifications. And of greatest importance and consideration is the continuous attention which must be given to these specifications to revise, amend or cancel, as such actions become necessary.

It is therefore clear that government specifications are not developed by a single

agency and are not available from a single source. However, all government specifications have an identifying number or symbol, and these symbols are frequently sufficient to give a clue as to their sources. The following symbols are in use by the many government agencies. Although this list is not represented as being fully complete, it does describe the identification systems of widest use at the present time.

Federal Specifications — Available by purchase from the Superintendent of Documents, Government Printing Office, Washington 25, D. C., and also from any of the ten regional offices of the General Services Administration. The cost is usually five cents, although some are higher. An *"Index to Federal Specifications"* is also available (40 cents per copy) from the Superintendent of Documents.

The specification symbol used to designate a federal specification has three component parts: *(a)* the group or class of products to which a specification relates; *(b)* the initial letter of the title of the specification; *(c)* a serial number determined by the alphabetical location of the title. Examples are C-G-463, GG-F-495, and LLL-B-441. The symbol C-G-463 identifies the federal specification for glue. The first component "C" is a designation for animal products. The letter "G" means glue, and the third component "463" means that of all words beginning with "G", the alphabetical arrangement of the successive letters thereafter forces the word glue into the 463rd position, thus the number 463.

"Interim Federal Specifications" are also issued. Here the symbol system is the same, excepting that it is followed by a parenthetical expression such as (GSA-FSS) or (NavyShips) or others. Interim federal specifications are intended for only temporary use, and under the procedures now being established they are to be coordinated and promulgated as federal specifications within a specified time. They are available from the issuing agency or from the Standards Division, Federal Supply Service, General Services Administration, Washington 25, D. C.

Of the existing and commonly used specifications of the several departments and other establishments, it is planned to convert many of these to federal specifications.

Department of Defense — Most of the specifications used in all agencies of the Department of Defense are known as "Military Specifications" and they carry a three-part symbol such as MIL-B-2532, the symbol being always prefixed by the letters "MIL". The second part of the symbol is a single letter to denote the alphabetic placement of the title and the third part is a number of up to five digits. Many MIL specifications are used by and available from many different agencies of the Department of Defense (Army, Navy, Air Force). However, certain of these specifications have symbols such as MIL-C-10113(CmlC) and MIL-C-10387(CE). The suffix in these two indicates custodianship or origin of the specification. The first (CmlC) is Chemical Corps; the second, Corps of Engineers; MIL specifications which carry no such suffixes are available from their custodians in accordance with very comprehensive indices on the subject. Such specifications should be requested, when needed, from contracting officers with whom suppliers are doing business or from the Department of Defense, Washington 25, D. C.

The prefix "JAN" is used in the same sense and with the same general meaning as MIL. However, JAN prefixes are being abolished. Interim Military (MIL) Specifications will be issued also, but the symbol system will remain the same.

The specification symbols used by agencies of the Government are as shown in the following tabulations. The individual specifications may be obtained without charge from the offices listed in the left-hand column.

Department of the Army

All agencies of the Department of the Army and the Department of the Air Force operated formerly under several different symbol systems. The most prominent of these was a two-part symbol, such as 3-169, 31-16 and 99-1. This type of symbol has one or two digits in the first part and up to three in the second. It was further expanded to provide subcategories, such as 50-54-15, 50-54-16, 97-45-343 and 97-45-344. Many of the symbols of this general pattern are still in use by agencies of the Army and of the Air

Force, although it is the intention to convert them to the MIL series. An index to all specifications used by the Army is available at $2.75 per copy from the Superintendent of Documents, Government Printing Office, Washington 25, D. C. The symbols and sources of specifications used by agencies of the Army are as follows:

	Symbol Identification
Chemical Corps	
Office, Chief Chemical Officer, Industrial Division, Production Branch, Army Chemical Center, Md.	MIL (certain ones) and MIL, plus suffix (CmlC).
Corps of Engineers	
Chief of Engineers, Administrative Service Division, Department of the Army, Washington 25, D. C.	MIL (certain ones) and MIL, plus suffix (CE). Symbols such as CE-214, CE-301.26, CE-242.2(INT), or CE-241(INT) are used; also PD- followed by up to three digits; also EC-EFP- plus three digits, EBP- plus three digits, T- plus three or four digits and miscellaneous numerical combinations such as 84-43 and 44-141. Last-mentioned types are being abolished.
Ordnance Corps	
Office, Chief of Ordnance, Department of the Army, Washington 25, D. C.	MIL (certain ones) and MIL, plus suffix (ORD). There are also the following prefixes followed by up to four digits:
	AXS- meaning Aberdeen Proving Ground, Md., or Detroit Arsenal, Center Line, Mich.
	FXS- meaning Frankford Arsenal, Philadelphia 37.
The "-XS-" specifications might be requested from the respective arsenals.	PXS- meaning Picatinny Arsenal, Dover, N. J.
	RIXS- meaning Rock Island Arsenal, Rock Island, Ill.
	SXS- meaning Springfield Armory, Springfield 1, Mass.
	WXS- meaning Watervliet, N. Y.
	Numerical combinations such as 3-197, 6-365, 50-17-20B, and 57-115-18 are used. ES plus three digits is also used.
Quartermaster Corps	
Coordinator, Research and Development Laboratories, Philadelphia Quartermaster Depot, Specifications Control Branch, 2800 South 20th St., Philadelphia 45.	MIL (certain ones) and MIL, plus suffix (QMC).
Signal Corps	
Signal Corps Supply Agency, Technical Records Branch, 225 S. 18th St., Philadelphia 3.	MIL (certain ones) and MIL, plus suffix (SigC). There are also numerical combinations such as 71-3304, 74-112 and 75-48. Last-mentioned symbols are being abolished.
Transportation Corps	
Marietta TC Depot, Marietta, Pa.	MIL (certain ones) and MIL, plus suffix (TC).
Army Medical Service	
Armed Services Medical Procurement Agency, Material Standards Div., 84 Sand St., Brooklyn 1.	MIL (certain ones). There are no MIL specifications with suffixes to designate this agency.

Department of the Navy

For many years the Navy used a symbol system such as 23 W 5, 32 B 66 and 6 F 3 for its specifications. The pattern was always the same: One or two digits, a single letter and one or two digits. Many of these specifications are still in use by the Bureaus of Supplies and Accounts, Ships, Aeronautics, Ordnance, and Medicine and Surgery. An index to all specifications used by the Navy is available at $2.25 per copy from the Superintendent of Documents, Government Printing Office, Washington 25, D. C. The symbols and sources of specifications used by agencies of the Navy are as follows:

	Symbol Identification
Bureau of Aeronautics Bureau of Aeronautics, Technical Data Division, Department of the Navy, Washington 25, D. C.	MIL (certain ones) and MIL, plus suffix (Aer). There are also symbols with prefix AN- plus a letter and a number, such as AN-E-19 and AN-T-1003. Miscellaneous combinations following the old Navy symbol pattern are still sometimes used, such as 16 R 93(Aer), 45 V 33(Aer) and 94 T 93(Aer). A few other combinations prefixed by symbols M, C, SR, EI, ET and R followed by up to four digits are also used.
Marine Corps Commandant, U. S. Marine Corps, Code USG, Washington 25, D. C.	MIL (certain ones) and MIL, plus suffix (MC).
Bureau of Medicine and Surgery Armed Services Medical Procurement Agency, Material Standards Div., 84 Sand St., Brooklyn 1.	MIL (certain ones) and MIL, plus suffix (BuMed). Certain few old Navy symbols still are being used, such as 18 O 2(INT), 29 S 9(INT) and 51 A 30(INT).
Bureau of Ordnance Bureau of Ordnance, Chief Engineer (REC.), Department of the Navy, Washington 25, D. C.	MIL (certain ones) and MIL, plus suffix (BuOrd). Certain few old Navy symbols are still being used, such as 15 C 13(ORD), 18 H 9(ORD) and 50 S 2(ORD). Miscellaneous symbols prefixed by the symbols OS and OSTD are also used.
Bureau of Ships Bureau of Ships, Code 357, Department of the Navy, Washington 25, D. C.	MIL (certain ones) and MIL, plus suffix (Ships). Certain few old Navy symbols are still being used, as 17 I 45(Ships), 45 V 34(Ships) and 66 F 5(Ships).
Bureau of Supplies and Accounts Bureau of Supplies and Accounts, Code S-33, Department of the Navy, Washington 25, D. C.	MIL (certain ones) and MIL, plus suffix (S&A). Certain few old Navy symbols are still being used, such as 24 B 13(INT), 27 C 19, 27 E 1(Sanda) and 55 R 6(Sanda).
Bureau of Yards and Docks Bureau of Yards and Docks, Code C 330, Department of the Navy, Washington 25, D. C.	MIL (certain ones) and MIL, plus suffix (Docks), such as MIL-L-15017 or MIL-H-15086(Docks). Certain few old Navy symbols still are being used, such as 17 B 8, 17 G 9, 41 N 5(Docks) and 43 W 3(INT); also uses symbols such as 2Yd and 5Yd.

Department of the Air Force

An index to all specifications used by the Air Force is available at $2.75 per copy from the Superintendent of Documents, Government Printing Office, Washington 25, D. C. The symbols and sources of specifications used by the Air Force are as follows:

Department of the Air Force	Symbol Indentification
Commanding Officer, Wright Air Development Center, Wright-Patterson Air Force Base, Dayton, Ohio. Attn: WCSDP-1.	MIL (certain ones) and MIL, plus suffix (USAF), such as MIL-T-6097 and MIL-R-6518(USAF). It also uses symbols such as AN-E-19 and AN-T-9; also old Army symbols such as 71-892, 71-5093 and 95-28108. It also uses symbols composed entirely of four or five digit numbers prefixed by an X or Y.

It is the aim of all agencies of the Department of Defense to convert all their specifications to the MIL symbol system. Certain specifications for which symbols are not given are either lesser known and used, or are classified.

Department of the Interior

Issues no specifications of its own authorship except in only a few rare instances.

Department of Agriculture

Forest Service	Symbol Identification
Purchasing Officer, Forest Service, U. S. Department of Agriculture, Washington 25, D. C.	Two or three-digit numbers followed by a single digit or letter such as 85-S, 241-2 and 277-1. Also symbols prefixed with the letters MSF, such as MSF-104. It also uses titles only, without symbols.
Forest Products Laboratory	
Forest Products Laboratory, Madison, Wis.	Three or four-digit numbers.

Post Office Department

Purchasing Agent, Post Office Department, Washington 25, D. C.	All specifications are known by their titles. Symbols are not used.

Department of Commerce

Civil Aeronautics Administration	**Symbol Identification**
Civil Aeronautics Administration, Department of Commerce, Washington 25, D. C.	Two-part symbol consisting of the prefix CAA followed by three digits, such as CAA-315.
National Bureau of Standards	
National Bureau of Standards, Washington 25, D. C.	Specifications are not issued by the N.B.S. However, it has taken a major part in the development of specifications for all standardization agencies, and it can supply information on the subject as required.
Office of Industry & Commerce	
Commodity Standards Division, Office of Industry and Commerce, Department of Commerce, Washington 25, D. C.	Issues "Commercial Standards" and "Simplified Practice Recommendations". Symbols are prefixed by CS or SPR followed by up to three digits.
Maritime Administration	
Maritime Administration, Department of Commerce, Washington 25, D. C.	Uses symbols of three parts, such as 18 MC 8 and 52 MC 18. First part is one or two digits. Second part is MC always. Third part is one or two digits.

Federal Security Agency

Food and Drug Administration	**Symbol Identification**
Food and Drug Administration, Washington 25, D. C.	No specifications as such. Has definitions and standards for foods known by the single symbols S.R.A. and F.D.C. 2. These are not specifications, but their substance could be appropriated to that use.

Housing and Home Finance Agency

Federal Housing Administration	**Symbol Identification**
Federal Housing Administration, Washington 25, D. C.	No specifications as such. Has "Minimum Construction Standards" known by titles only, and may be used as specifications.

Panama Canal

Panama Canal, 411 Tenth St., N.W., Washington 25, D. C.	Has specifications by title only. No symbols are used.

Miscellaneous

General Services Administration	**Symbol Identification**
Any regional office of GSA, or Federal Supply Service, General Administration, Washington 25.	These symbols are straight three or four-digit numbers. Four-digit numbers from 2000 to 3000 are known as Interim Federal Specifications.
Veterans Administration	
Purchasing Officer, Veterans Administration, Washington 25.	Symbols are two and three digits prefixed by the letters VA.

High-Speed End Heating of Sucker Rods for Upsetting

By D. R. Dale, Chief Engineer, S. M. Jones Co., Toledo, Ohio

MORE THAN 400,000 oil wells are being pumped in the U. S. today from depths averaging more than 3600 ft. between the oil horizon and the earth's surface. The pumps used are generally of a plunger type, with the barrel attached to and usually suspended at the bottom of the oil-well tubing. The pump, in other words, is down near the bottom of the well. The plunger is attached to the bottom of a long string of steel rods called sucker rods. The reciprocating motion of the rods and plunger within the tubing and pump barrel lifts the oil to the surface.

One can imagine the troubles of removing the bottom end of a string if one of the sucker rods should break. In their manufacture hot rolled carbon or alloy steel stock is used. The stock is first straightened, ends heated and upset for threaded connections, then normalized, machined, and sometimes polished (to remove stress-raisers). In heating for forging, experience has shown that the stock must have minimum scale for best forging, and minimum decarburization for best thread cutting. In other words, bars must be brought to heat in a minimum of time and the heated bar be ready for the forge operator at just the right temperature and moment. Overheating will produce a "sagging" bar with excessive scale and decarburization; underheating, on the other hand, will result in costly reheating.

S. M. Jones Co. has been producing highly satisfactory sucker rods since 1894 for oil wells all over the world. At the present time a string of its "Green Line" rods is functioning in the world's deepest pumped well. This California well is nearly 12,000 ft. deep and has been operating continuously for about six months without a sucker-rod break. Maximum load due to weight of the steel itself is 28,950 lb. in this well (about 8½ times the weight of the column of oil inside the casing) and the alternating stress carried by the rod is about 37,000 psi. max. in tension. The steel is A3310 (3.5% Ni, 1.5% Cr).

For some years slot furnaces, conventional gas-fired, were utilized at S. M. Jones Co. with limited success. Production rates were adequate but results, rod-to-rod, were not consistent. Sometimes excessive scaling, sometimes decarburization was encountered. Production costs were unduly high due to rejects and die maintenance.

For these reasons, Surface Combustion Corp. was asked to design and develop a special unit applying the advantages of high-speed gas heating. Initial specifications required maximum production with uniform heating and minimum scaling or decarburization of stock sizes ranging from ⅝ to 1 in. in diameter and heated ends from 14½ to 17½ in. long on 30-ft. bars.

A new high-speed gas heating design was accordingly developed incorporating a split side-wall heating chamber with gas-fired line burners firing vertically downward onto a refractory bed or hearth. In simple language, the new design was basically a slot forge furnace with the conventional refractory-lined side-walls, but with side-firing burners eliminated. The side-walls of the furnace were also slotted so the bars, side by side, could pass through from storage table to upsetting press. The resulting unit proved readily adaptable to automatic handling. These features are shown in Fig. 1.

To concentrate maximum heat in the working area, a bed of refractory material extends the length of the hearth under each of the two line burners (Fig. 2). This arrangement maintains extremely high rates of combustion by completely burning the gases in the narrow confines of the working hearth. Rod-ends are rapidly heated not only by the hot products of combustion but also by radiation from the incandescent refractories above and below — a rather remarkable accomplishment despite the losses through the three open sides of the heating chamber.

Construction of the two line burners on each forge furnace is probably clear enough in Fig. 2. The water-cooled upper casing is of welded steel plate and the lining is a castable refractory. Hearth is of loose Alundum (Al_2O_3) lumps in a castable refractory de-

Improved Rates of Heat Transfer

pression. While the bars ride through without scraping the hearth, the Alundum has three important properties — abrasion resistance, refractoriness, and slow reactivity with hot iron oxide.

After four of these new furnaces were initially placed on the line, it became evident that, in addition to marked production increases, the general working conditions and over-all operations also improved. Production considerably exceeded the designed capacity, and finally the rates shown in Table I were achieved. Continuous production also resulted in a high fuel efficiency, about 14% for these furnaces — that is to say, 14% of the total heat of combustion in the gases burned was absorbed by the steel.

The heating rates shown in Table I represent an increase in satisfactorily heated bars of between 60 and 70% over those attained in the conventional slot forges that were replaced. There was also a marked reduction in rejects due to such conditions as poor metal flow and nonuniform filling of the dies. Rejects of forged bars are now 0.3%; previously they were from 1 to 1.5%.

Rejects due to poor machining characteristics were also considerably reduced. Microstructural studies show very clearly the decrease in depth of decarburization resulting from high-speed heating. When a rod is heated to 2250° F. in 3.83 min. in one of the new furnaces, a layer 0.003 to 0.004 in. of near-ferrite is produced. In a conventional slot forge where the rod was heated to 2250° F. in 15 min. it is decarburized to near-ferrite to a depth of 0.007 to 0.008 in.

The extent of this decarburization is important, not only in thread cutting but due to the fact that connections on these sucker rods must stand up under heavy alternating loads. Threads act as stress raisers and it is essential that no weak, low-carbon material exist at the roots of threads. In fact, the threads must be uniform and the rods machined so they "shoulder" perfectly — if not, the connection will loosen and the rod break.

Forging die maintenance, which can often prove a costly item, was considerably decreased. The previous daily die grinding was reduced to one grind every three days on the same set of dies. This was due in considerable measure to the high heating rate with the new heating units which reduced visible scale about two thirds in thickness.

Each "Surface" high-speed end-heating furnace is rated at 2600° F. hearth temperature. Each bar end is uniformly heated to a forging temperature of 2200 to 2250° F., as required. Horizontal travel of 22 in. (effective hearth length of 18 in.) is accomplished under direct flame contact. The flame impacting upon the refractory bed transforms this surface into a radiant burner face. The high velocities of the burning gases, as they

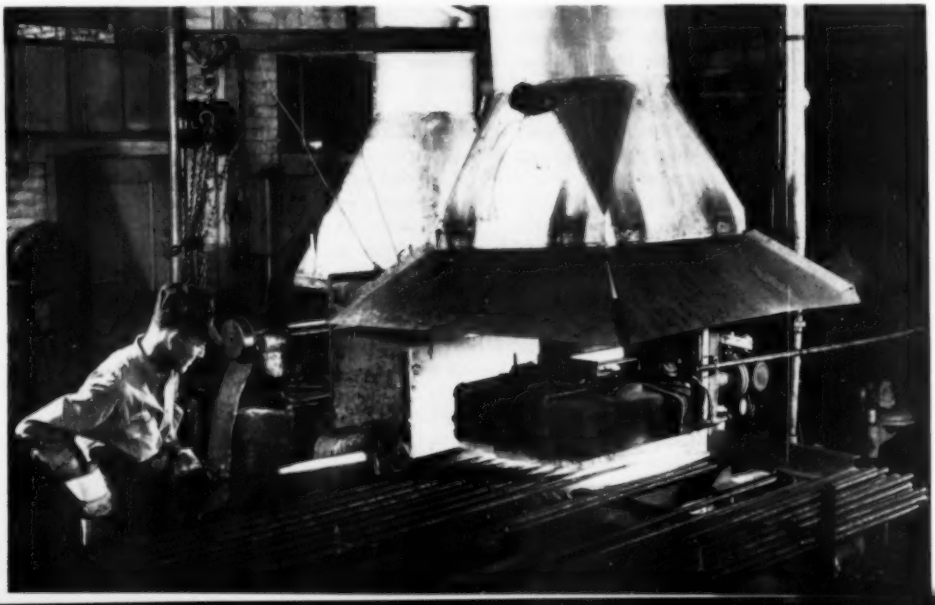


Fig. 1 — Efficient Forge Furnace of Radically New Design Heating Alloy Steel Rods. Ends are upset and threaded for sucker rods, used in large number in oil wells

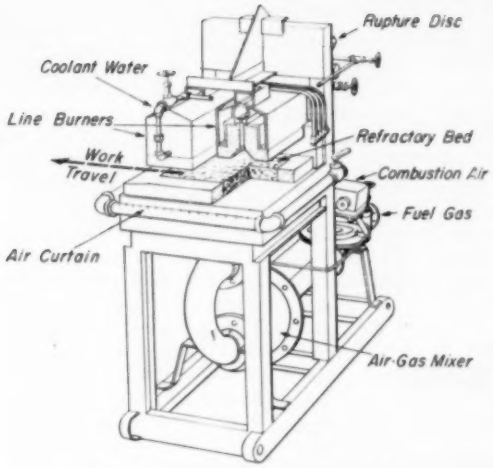


Fig. 2 — Perspective Sketch (Partially Cut Away) Showing Construction of Forge Furnace. Two line burners fire directly down on Alundum hearth

spread out on contact with the refractory material, accelerate combustion so as to minimize contact of partially burned gases on the steel.

Heat transfer by convection also becomes an important contributing factor in this arrangement. Calculations show that heating time is reduced from 15 to 20% over what would be required by pure radiation. Further application of the well-known fact that heat is transmitted as the fourth power of the temperature difference between radiant source and receiving surface makes it apparent that this burner arrangement is capable of transferring heat energy with remarkable intensity. All work surfaces are thus uniformly exposed without shadow effect or cold spots. Hence it is unnecessary to rotate the bars as they travel through the slot. Practical evidence of this is found in the high heating rates attained, as shown in Table I.

In the installation at S. M. Jones Co., natural gas is the fuel. It is introduced at the rate of 2200 cu.ft. per hr. under 48 oz. pressure, together with combustion air at 1100 cu.ft. per min. and 40 oz. pressure, to a variable orifice mixer located below the furnace hearth. Central gas and air compressors are manifolded to all four furnaces.

Ratio of fuel and air in this mixer is controlled within very close limits, over a wide range of turn-down, by an adjustable plate.

Operation Is Simple

Turning a single screw opens one orifice and simultaneously closes the other. The resulting combustion mixture is manifolded to the water-cooled line burners at about 30 oz. pressure.

Individual burner manifolds are connected to a single header equipped with a rupture disk so arranged as to protect the air-gas mixture from backfire and to divert any manifold disturbance upward and away from the operator and mixing equipment. A section of flexible corrugated tubing permits normal expansion and contraction. This construction eliminates the need for firechecks and premixing machines.

Safety control equipment includes an electrical interlock system that operates a shut-off valve in the gas line if gas, air or water pressure fails.

In handling a range of stock sizes the only necessary adjustments are changes in the conveyer speed. Bars are spaced 2¼ in. on center for all sizes. This is done automatically by dogs on the traversing mechanism shown in Fig. 1. Since uniformity of heating is assured, each bar in a run is exposed to the same amount of heat, and human errors are thus eliminated.

The simplicity of this setup is appreciated by the forge operators. Lighting the furnace is a simple matter; the operator needs give no attention to the furnace during the day. The furnaces are up to temperature and ready to operate in about 10 min. (The previous conventional furnaces required about 60 min.)

The compact size of these units has also eliminated some stock handling. They occupy a floor space of 13.2 sq.ft. and are 2 ft. wide. The old furnaces (which were also placed as close to the upsetters as possible) required 29 sq.ft. and were 5 ft. 2 in. wide. Because

(Continued on p. 194)

Table I — Maximum Production Rates

Work at 2250° F.	Diameter of Bars Heated		
	¾ In.	⅞ In.	1 In.
Rods per hr.	173	167	167
Length of heated end	13½ in.	15 in.	16 in.
Conveyer speed, in. per min.	6.48	6.26	6.26
Rod temperature	2230° F.	2220° F.	2240° F.
Mixture pressure	28 oz.	20 oz.	26 oz.

By Arthur H. Allen, Technical Business Consultant, Cleveland

Electric Furnace Department Manufactures Large Ingots for Specialized Forge Plant

PRODUCTION of specialty steels for die blocks and heavy forgings in conventional electric furnaces calls for a high degree of control from raw material to finished ingot. This is readily observable from a visit to the new $2,500,000 melt shop recently put in operation by A. Finkl & Sons Co. in Chicago. Instrumentation, control procedures and laboratory facilities are of the highest order, thus backing up modern furnaces, accessories and materials handling equipment, centering around two top-charge electric melting furnaces of 30 tons capacity.

Finkl is an old name in the forging field, dating back to 1879 when German-born Anton Finkl came to Chicago to establish himself in business in a small way. The business prospered and his three sons, Charles, Fred and Frank, joined him. All now are dead, the founder being active until his passing at the age of 90. Grandsons William and Alfred now are president and vice-president of the firm, respectively.

The new electric melting department may be thought of as ushering in the fourth phase of the company's progress. First, of course, was the period of early development when the problem was to make, competitively, forgings of all sizes and shapes — mostly small. During this time the firm acquired a reputation for its die blocks, then usually made of plain carbon steel (0.40 to 0.70% carbon, depending on ultimate use), machined or die-sunk in annealed condition, and then hardened properly (if luck was with the hardener).

The second phase began when the present president entered the firm as metallurgist, a third of a century ago. Alloy steel die blocks had already made their appearance; nickel, nickel-chromium, and chromium-vanadium steels were being made by Finkl as well as by competitors. Bill Finkl's immediate job was to produce a more durable die block which could be deep hardened below the depth of the deepest impression. It is interesting to note that he turned to the nickel-chromium-molybdenum combination, and this in a day (1919) when molybdenum was the newest of the new, as far as American steelmaking practice was concerned. It was a sound choice, for this analysis in various "balances" is still most widely used for hot work die steels. One modification was promptly put into heavy forgings for machine parts requiring high strength and toughness in the fully heat treated condition, such as drop-hammer piston rods and upsetter cranks, and became the basis for the present S.A.E. 4300 series. With high silicon it makes fully air hardened die blocks; with high carbon it can be heat treated hard enough for cold trimmers and punches; with copper substituting for some of the nickel the machinability is considerably improved at high hardness levels.

The third phase of progress* was ushered in by the construction of a specialized heat treatment plant. The furnaces were designed for uniform heating of heavy pieces of carbon and alloy steel, completely instrumented for automatic control, and equipped with most modern quenching equipment. Furnaces for isothermal annealing after preliminary press forging or upsetting reduce the danger of thermal ruptures and prepare the structure for further heat treatment.

Experience had led to a technique that submits all heat treated products — and that includes about 90% of all production items — to the severest quench the material can withstand, with automatic mechanisms controlling both water and oil quenching temperature ranges. Hot ingots go direct from the new steel plant into holding furnaces which receive the ingots immediately after they are lifted out of their molds and hold them steadily at moderate temperature (1200° F.) until the forge shop is ready for further operations on them. Thus, most of the initial ingot heat is retained and economy

*See *Metal Progress*, October 1947, p. 584.

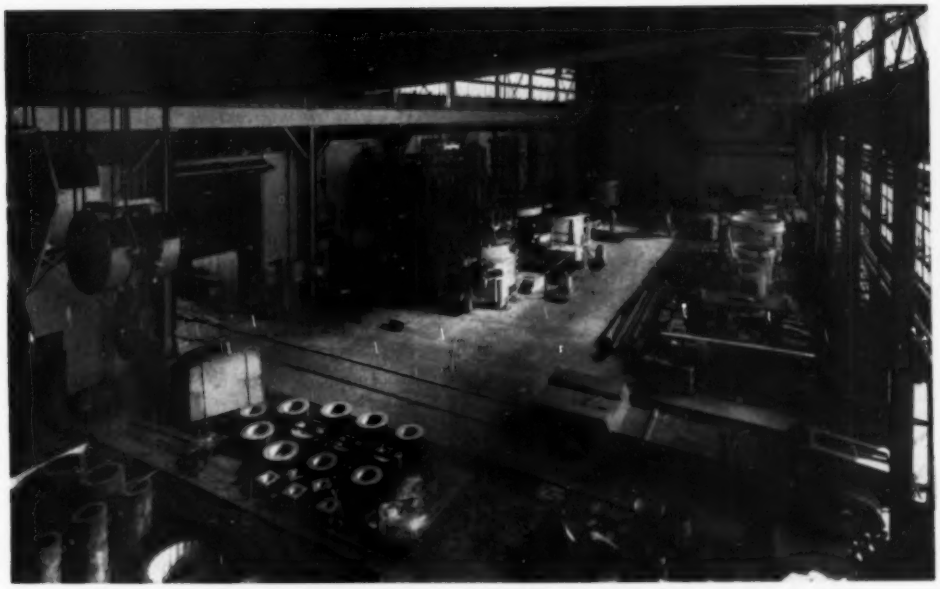


Fig. 1 — Orderly Arrangement of the New Melt Shop Is Evident in This View Taken at Crane's-Eye Level. Ingot pouring area is at the lower left. Large trailer is used to move hot ingots across a street to the forging shop

of operation improved over the former practice of having to heat cold ingots for forging.

There are four such furnaces, three of 150-ton capacity in which several ingots may be placed; the fourth is somewhat smaller, even though it is designed for single large ingots weighing up to 55 tons. Holding furnaces are of unusual design in that they incorporate a water seal around the car instead of the conventional sand seal. The water seal was pioneered by Finkl engineers a number of years ago and is used on other furnaces in the heat treating department.

ELECTRIC MELT SHOP

The construction of the melt shop noted at the very outset of this article may be regarded as the start of the fourth phase of the firm's development. Historically, the company has purchased its steel in the form of large-sized ingots and blooms from steel mills principally in the Pittsburgh area. All forming operations at the Chicago plant involve direct forging from this raw material, Finkl having no rolling mill. At the present time, about 70% of total output is of alloy steel, 30% of carbon steel.

In the face of increasing production and in a period when shortages of forging ingots made it difficult to buy sufficient tonnage, it gradually became apparent that supply problems would be eased and a number of important added economies might be realized by setting up a self-contained melt shop. Savings on the freight costs of ingots secured outside the Chicago district, on the cost of reheating them for forging, on the expense of maintaining a substantial inventory of ingots, and the obvious advantages of making your own steel to your own specifications as against buying it on the outside — all these factors motivated the decision to erect a modern melt shop despite relatively high equipment costs. It was believed that this addition to plant facilities would improve control of steel quality, while output could be geared to the varying demands of the forge shop.

Two new 30-ton, Pittsburgh 'Lectromelt, top-charge basic electric furnaces were installed in a completely new 75 x 425-ft. brick and steel mill building shown in the accompanying view. They are served by two overhead cranes, one of 100-ton capacity (with 20-ton auxiliary hoist) and the other of 40-ton rating with 10-ton auxiliary.

New Melt Shop for Forge Plant

Heavy purchased scrap is stored in outside concrete bins accommodating about 10,000 tons. Cranes load it into charging buckets carried on a transfer car which can be moved quickly into the building, under the traveling crane and thence to the furnace being charged. Buckets have the "clam-shell" bottom-drop arrangement, and will carry 20 to 25 tons of scrap, almost sufficient for one furnace charge.

Balance of the charge is made up of ingot butts, crops, flashings, scale and other home scrap. The latter material is handled by crane and magnet having a combination of SR-4 strain gage on the magnet connected to a direct-reading electronic potentiometer in the crane cab. This gives an instantaneous reading of the weight being lifted and speeds up the charging operation.

Initial heats of steel were poured early in April 1952. They were of fine-grained S.A.E. 1035 killed steel, and were designed more or less to break in crews and equipment prior to processing the first alloy heats. A typical log of one of these first carbon steel heats is shown in Table I.

Tilting mechanisms for the furnaces are erected below floor level, and a concrete-lined pit or well between facing spouts accommodates ladles large enough to receive a full tap (of both furnaces, if necessary). All ingots are poured big-end-up with hot tops. (The ingot hot top also serves as a tong-hold in forging.) A variety of different sized molds is stocked, ranging from 19 to 54 and even 62 in. diameter, the latter two sizes requiring the contents of both furnaces.

Ladles are handled from furnace to ingot pouring pit by overhead crane, conventional types of 30 and 50-ton, bottom-pour ladles being used.

Oxygen is used regularly when finishing electric furnace heats, to bring the carbon content within specified limits. Therefore, a complete piping system has been installed in the melt shop, connecting with a liquid oxygen station in the yard where gas is manifolded into plant lines through pressure-reducing valves. The lines also are carried to the adjoining chemical and metallurgical laboratory, which is the focal point for operating control data.

Temperature and Metallurgical Control — Temperature of the steel bath is an important factor affecting its quality, particularly if an alloy heat. Temperature at tap is a measure of fluidity, while temperature at the time of alloy additions and oxygen lancing has an important bearing on metallurgical quality. To aid the melters in establishing close control, a "dunker", or immersion Rayotube pyrometer equipment (Leeds & Northrup), has been installed. It consists basically of a steel tube about 8 ft. long with a $\frac{9}{16}$-in. orifice in one end and an enclosed radiation-sensitive device sighted through the orifice. The orifice end is immersed in the molten metal of the bath for approximately 4 sec.; clean, dry air under pressure keeps the tube clear of molten metal and slag. The air forms a bubble or pocket in the bath immediately beyond the orifice and the temperature is measured in terms of radiation from the molten steel forming the walls of the pocket. The end of the tube is protected with a replaceable graphite tip plus a 36-in. protective sleeve of heavy cardboard pushed over the end.

The immersion unit is connected by electric cable to a high-speed indicator-recorder located convenient to the furnaces. The sensing element of the tube is a sealed system of windows, lenses and thermocouples in series. Its successful operation is dependent upon a supply of clean, dry air, so a supply unit (including flow reg-

(Continued on p. 196)

Table I — Log Sheet for Carbon Steel Heat

Time	Charge or Operation	Weight	
		Metallics	Nonmetallics
7:50 a.m.	Lime and scale	1,500 lb.	500 lb.
	Flashings	10,000	
	Plate	19,780	
	Crops	20,600	
	Pig iron	4,620	
8:15 a.m.	Current on		
10:00 a.m.	Lime and pig iron	500	500
10:20 a.m.	Fluorspar		100
10:35 a.m.	Ferrosilicon (50%)	180 (to block heat)	
10:50 a.m.	Ferromanganese (80%)	300	
11:05 a.m.	Ferrosilicon	240 (to ladle during tap)	
	Aluminum	38 (to ladle during tap)	
11:14 a.m.	Tap completed		
11:40 a.m.	Four ingots poured.	57,803 lb. total metallics	

Elapsed time from charging: 3 hr. 50 min. Tap temperature, 2970° F.
Power consumption, 13 kw-hr. Pouring temperature, 2840° F.

Identification of Fractures in Cast Magnesium Alloys

By P. F. George and H. A. Diehl, Magnesium Laboratories, Dow Chemical Co., Midland, Mich.

THE CHARACTERISTICS of failure-fractures of magnesium castings used in normal load-carrying components and reciprocating units give a reliable clue to the cause of failure. Examination is made with and without magnification of the surfaces, the magnification being 25 to 100 ×* (herein called macro-examination) and up to 250 ×* (micro-examination). A stereo-binocular microscope and oblique lighting are used for the lower magnifications, a metallograph for the higher powers; a conventional specimen mount is made of the area of the fracture for the latter procedure. A schematic plan for distinguishing the cause of fracture by a systematic examination is given in the data sheet on page 96-B.

Visual Examination — A fracture should be examined without magnification to detect differences in texture and color over the entire surface (oily samples can be cleaned in acetone or perchlorethylene), and to locate the origin of failure. A smooth, fan-shaped fracture with a definite starting point is almost sure to be due to fatigue. Texture of the fracture shows the distance fatigue progressed until the rest of the section failed by tension or impact. Stress-corrosion cracking, although uncommon in magnesium casting alloys, has many starts and branch cracks, often visible in the surface of the casting near the start of the main fracture.

Macro-Examination — Fractures which have flat facets or cleavage planes are either fatigue cracks or stress-corrosion cracks. Careful examination at low power will distinguish between them; many branch cracks occur in the stress-corrosion fracture which are absent from the fatigue fracture.

A fracture which is irregular and contains few, if any, branch cracks is either a tension failure or a fracture which occurred at a temperature above normal. If the metal is in the as-cast state, the tension fracture will be completely irregular and will contain no facets. Metal in the T4 or T6 condition (A.S.T.M. designation: T4 is solution heat treated; T6 is solution heat treated plus artificially aged) will show scattered small facets when fractured in cold tension. Fractures in T4 or T6 metal which have occurred above 450° F. will be intercrystalline and have flat grain surfaces. In general, transcrystalline cracks show the flat facets whereas the intercrystalline cracks show wave-faced crystallite faces.

Micro-Examination of As-Cast Metal — The intermetallic compound at the grain boundaries determines the path of the fracture when the metal is broken in tension. Figure 1 shows the profile of such a break with the path of the main fracture progressing along the grain boundaries with short cracks across compound particles near the fracture. The fracture occasionally takes a transcrystalline course when the compound network is not continuous and tends to follow the voids if porosity is present.

Intercrystalline fractures which do not show the small cracks across the compound particles near the main crack are due to failure above 450° F. Intercrystalline paths are taken by fatigue fractures that occur above 300° F. Cracks produced by stressing above the eutectic temperature, such as shaking a casting from the mold before the eutectic has solidified, appear as a continuous line of porosity, as shown in Fig. 2.

Fractures resulting from stress-corrosion and fatigue follow a transcrystalline path. The fatigue fractures are fairly straight and are not affected by intermetallic compounds or even porosity. There are no short cracks in the compound near the fatigue portion of the fracture, but cracks will be found in the tension failure with which this fracture always ends. Figure 3 shows a characteristic fatigue fracture in AZ92 alloy.

Metal failing by stress-corrosion will have many branch and parallel cracks. Stress-corrosion cracks also tend to follow definite planes in each crystal and avoid intermetallic compounds (if present). Profile of a stress-corrosion crack is shown in

*EDITOR'S FOOTNOTE — The original micros were made at these standard enlargements, but have been reduced in reproduction to the magnification shown in the captions.

Fig. 1 — Tension Fracture in As-Cast AZ63. Intercrystalline fracture follows intermetallic compounds. Short side cracks in the compound are near the main fracture. 175 ×

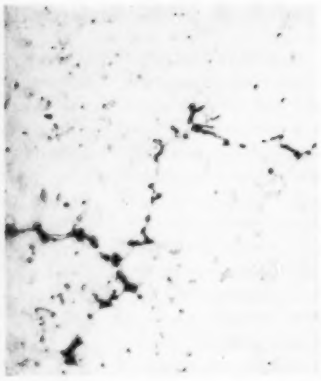


Fig. 2 — Hot Fracture in As-Cast AZ63 Alloy. With metal above the eutectic temperature, the crack follows a series of interconnected voids. 75 ×

Fig. 3 — Fatigue Fracture, Straight and Transcrystalline, in As-Cast AZ92. (The dark areas are lamellar precipitate.) 150 ×

Fig. 4 for as-cast AZ63 alloy. Shear fractures are also transcrystalline but show many twins near the fracture. Shear fractures are usually easy to determine.

T4 or T6 Metal — Intercrystalline fractures in metal in the T4 condition are due to tension above 450° F. and fatigue above 300° F. Hot-short cracks are intercrystalline, as described above for as-cast metal.

Most fractures in T4 or T6 metal are transcrystalline. If the rupture is irregular by following definite planes in crystals, it is caused by either tension or stress-corrosion.

Tension failures have few, if any, branch cracks, while the stress-corrosion type has many. Tension cracks tend to follow any undissolved compounds left after heat treatment; stress-corrosion cracks will avoid them. Figure 5 shows a tension and Fig. 6 a stress-corrosion fracture in AZ92 in the T4 condition.

If the transcrystalline cracks are fairly straight, they can be due to fatigue, shear or perhaps stress-corrosion. Stress-corrosion failures have many branch cracks somewhere on the fracture, while the fatigue and shear cracks have very few. The metal will contain an abundance of twins near a shear fracture, while only a few twins will be present near a fatigue fracture.

Fig. 4 — Stress-Corrosion Cracking in As-Cast AZ63 Alloy. Many branch cracks follow definite planes in each crystal. 85 ×

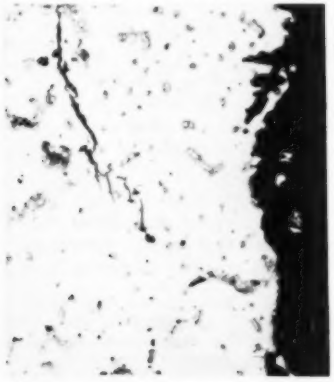
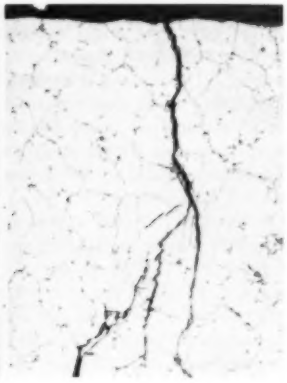


Fig. 5 — Tension-Fracture in AZ92 in T4 Condition. Fracture is transcrystalline but irregular. Side cracks are short. 200 ×

Fig. 6 — Stress-Corrosion Cracking in AZ92 (T4) Is Transcrystalline and Follows Definite Planes. Many branch cracks. 85 ×



Controlled Atmosphere Tempering

By Harold N. Ipsen and Donald R. Mathews

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UNTIL RECENTLY the use of controlled protective atmospheres in the tempering of iron and steel articles was not given much serious consideration. The oxide layer was not detrimental because a much heavier oxide was already present due to the preceding heat treatment.

The picture began to change when clean, bright, scale-free work was consistently produced at the higher heat treating temperatures. (An article discussing some phases of this development was published in the February 1951 issue of *Metal Progress*: "Bright Hardening, Carburizing, and Carbo-Nitriding" by H. Ipsen and R. Krogh.) Metals engineers then naturally looked for a tempering process which would retain the bright surface and eliminate subsequent cleaning or pickling.

In spite of this usual preference for bright tempered work, an oxide coating formed under carefully controlled conditions often is highly desirable. This, however, is true only if the proper oxide is produced as a rather thin layer.

The controlled atmosphere tempering process, therefore, can be thought of in two very distinct ways: First, as a bright tempering process in which oxidation is to be avoided to as great an extent as commercially possible and, second, as a process of controlled oxidation in which a particular oxide of definite thickness is formed.

The purpose of this paper is to describe briefly the theoretical considerations involved and the desirable conditions to be striven for in carrying out either scheme. An appropriate process and equipment will then be described in some detail.

LOW-TEMPERATURE SURFACE REACTIONS

Careful control of the atmosphere is the first essential in regulating the reactions between it and the steel surface. Separate consideration will be given to the two types of controlled atmosphere tempering — bright tempering and controlled oxidation.

Bright Tempering — Since a bright tempering operation is largely concerned with avoiding oxidizing reactions, an atmosphere is required which has highly reducing properties and will, therefore, tend to combine and fix any oxygen which approaches the steel. At the same time the atmosphere should have sufficient carburizing potential so carbon will not be removed from the surface of the higher carbon steels.

It has been found that an "endothermic" base atmosphere satisfies these requirements very well. It is prepared by the partial combustion of fuel gas in contact with a heated catalyst; the composition of the resultant gas mixture varies with the ratio of air to gas fed into the preparation unit. A typical approximate composition suitable for bright tempering is 18% carbon monoxide, 35% hydrogen, 1.0% carbon dioxide, 2.0% water vapor, 0.0% methane, and 44% nitrogen. Hydrogen furnishes the reducing properties while carbon monoxide provides the carburizing potential.

An early difficulty encountered with endothermic gas was the deposition of carbon on the work at low tempering temperatures or during cooling from higher tempering temperatures. Carbon monoxide decomposed into carbon dioxide and carbon, thus

$$2CO = CO_2 + C \qquad (1)$$

This reaction could be prevented by a proper amount of water vapor, and this could be measured by dew point readings. An increase in water vapor results in a chemical reaction between carbon monoxide and the added water, as shown by the equation

$$H_2O + CO = H_2 + CO_2 \qquad (2)$$

This reduces the quantity of carbon monoxide in the atmosphere and controls its tendency toward carbon deposition or sooting.

It was found that 2% H_2O was sufficient to prevent carbon deposition on the work. This corresponds to a dew point of +65° F. Even though considerable carbon monoxide remains in the altered atmosphere, the resulting rate of decomposition seems to be sufficiently low so that no sooting occurs

with normal temperature and time cycles. On the other hand, lower percentages of water vapor in the atmosphere seemed invariably to result in the deposition of considerable carbon.

However, there must be a limit placed on the water vapor, else the carburizing potential will be lowered. This potential varies with temperature and the carbon content of the steel and is better determined by experiment than by prediction. It can be stated in general terms that for the comparatively low temperatures and short time cycles involved in tempering it is not difficult to maintain the surface carbon concentration without change. The balance between carburizing and decarburizing reactions is close enough and the diffusion rates are low enough to maintain substantial equilibrium.

The original difficulties, therefore, generally are resolved into the single problem of sooting, and this is prevented by controlling the dew point of the protective atmosphere, as described above. Dew point is controlled by simply varying the proportions of air and gas being reacted in the endothermic generator. The actual ratio required to produce a given dew point will depend entirely upon the composition of the fuel gas being used, and again is a matter for preliminary determination.

Properly controlled, as outlined above, there is no problem in producing bright tempered work with an endothermic atmosphere. The resulting articles are clean, bright, and scale-free. They are ready for subsequent processing operations, such as plating or painting, without the need for cleaning or pickling operations. As can readily be realized, the savings in processing cost and time are considerable.

CONTROLLED OXIDATION

In controlled oxidation processes the object is to produce a particular form of iron oxide of controlled composition and thickness. The desired oxide is the magnetic iron oxide, Fe_3O_4, and the process must form Fe_3O_4 in preference to other oxides of iron. Magnetic oxide is tight and adherent and possesses the advantages listed below:

1. Increased life of many high speed steel cutting tools.
2. Improved service in parts subject to wear; it "holds" the lubricant.
3. Corrosion resistance is enhanced.
4. A pleasing bluish-gray to bluish-black appearance.
5. Visual proof that the tempering operation has been performed.
6. Ease of cleaning. Admittedly, the bright tempered surfaces are preferred; however, the controlled oxide coating can be much more easily removed by pickling than the oxide produced by uncontrolled exposure to an ordinary air atmosphere during tempering.
7. In the electrical industry the oxide coating provides desirable insulating properties for certain parts.

There are three temperature ranges of importance. Their limits are not definite, fixed temperatures, but are believed to vary, depending upon the time of exposure and the composition of the material treated. The reactions which occur when iron and steel are exposed to air atmospheres and water atmospheres in these three temperature ranges will be discussed.

300 to 700° F. — When steel is heated in contact with air or water in this temperature range, superficial oxides are formed, the thickness depending upon the temperature and time of exposure. Even prolonged treatments at 700° F. and below will not produce oxides which are objectionably thick, they merely color the steel. Since the oxide is not of appreciable thickness, no control is necessary unless the so-called "temper color" is objectionable.

The oxide of iron formed in this temperature range is believed to consist entirely of Fe_3O_4. It is formed by the following reactions in air and water atmospheres:

$$3Fe + 2O_2 = Fe_3O_4 \qquad (3)$$

$$3Fe + 4H_2O = Fe_3O_4 + 4H_2 \qquad (4)$$

As temperature and time are increased, the color of the oxide changes from a straw color to a dark blue.

700 to 1060° F. — In this temperature range Fe_3O_4 is still the predominant oxide formed according to reactions (3) and (4). The color ranges from blue to bluish-gray or bluish-black in appearance. The rate of reaction is greater than in the lower temperature range and, if exposed for too long in air, the oxide is apt to become loose and flaky. When exposed to an atmosphere containing the proper amount of water vapor, a hard, adherent coating is formed with the desired properties.

Excessive air must not be present in the atmosphere. A combination of air and mois-

ture is likely to produce ferric oxide, Fe_2O_3, which is a loose, powdery oxide, possessing none of the desired properties:

$$4Fe + 6H_2O + 3O_2 = 4Fe(OH)_3 \quad (5)$$
$$4Fe(OH)_3 = 2Fe_2O_3 + 6H_2O \quad (6)$$

Both air and moisture are necessary for these reactions, and the reactions can conceivably occur if humid air is used. Note that the moisture used in the first reaction is regenerated in the second. The above reactions are, therefore, always to be guarded against in a controlled oxidation cycle.

1060 to 1400° F. — When steel is exposed to air or water in this temperature range, ferrous oxide, FeO, forms adjacent to the steel surface and subsequently oxidizes to the higher oxides of iron, Fe_3O_4 and Fe_2O_3. The resulting oxide coating is very complex in structure and consists of at least three layers, with FeO bordering the iron and followed in turn by Fe_3O_4 and Fe_2O_3. Under the microscope the FeO is generally darker or more grayish than Fe_3O_4, while Fe_2O_3 may vary in color from a bluish-black to its more normal color of red or brownish-red — the familiar iron rust.

In this temperature range the relative thicknesses of the respective oxide layers are determined largely by the temperature. FeO grows in thickness with increasing temperatures while the Fe_3O_4 and Fe_2O_3 layers thicken very slowly. When cooled, the FeO is unstable below 1060° F. and dissociates as follows:

$$4FeO = Fe_3O_4 + Fe \quad (7)$$

This is undesirable if optimum properties of the coating are wanted, because the finely divided iron particles promote corrosion and lower the electrical insulating properties. However, in rough work, the oxide layers and the iron particles may not be objectionable.

DESIRABLE CONDITIONS

As a result of the study of the theory, advantages, and applications of controlled atmosphere tempering, it is now feasible to accumulate a list of desirable conditions which should be striven for in developing an ideal process.

1. A commercial furnace which can be used interchangeably as a bright tempering unit, a controlled oxidation furnace, or an air atmosphere tempering furnace.

2. An endothermic atmosphere which can be in contact with iron or steel for an extended period without harming the surface, thereby resulting in a bright surface after tempering.

3. Use of water as an oxidizing atmosphere when controlled oxidation is desirable. The water can be admitted directly into the furnace heating chamber without resorting to the extra complication of a steam pipe from a process line or a separate steam generator.

4. Further control over the controlled oxidation process by using the endothermic atmosphere during the early part of the heating cycle and supplanting it with a moist atmosphere at the end. A prior heat treating operation such as tempering or annealing can then be performed in the same equipment but entirely independent of the final oxidation; the articles are bright until ready for the oxidation portion of the cycle. Thus, the oxidation can be held under closer control and can be carried on for any desired time at any temperature.

5. Incorporation of an atmosphere-sealed cooling chamber and quench tank as an integral part of the furnace. Transfer from the heating chamber can then be done in a protective atmosphere, and cooling can be carried out in a variety of mediums and at any desired speed. The process time can thus be shortened considerably and greater control maintained over the results.

Fig. 1 — Part of Laboratory Devoted to Studies of Production Heat Treating Showing Draw-Quench (DQ) Combination Tempering Unit at Right

Controlled Atmosphere Tempering Process

6. Clean, bright surfaces on parts going into the furnace are necessary if satisfactory results are to be obtained. This is especially true in controlled oxidation cycles for which ground surfaces are ideal; surfaces must also be clean and free of oil or grease.

Keeping in mind the desirable conditions outlined for an ideal process, Ipsen Industries, Inc., has developed two new series of controlled atmosphere tempering units, tradenamed Series "D" and Series "DQ".

COMPACT, VERSATILE SYSTEM

The Series "D" tempering units were designed specifically for controlled atmospheres, although they can be used interchangeably with conventional air atmosphere. It consists of the furnace-end of the combination shown in the general cross section, Fig. 2, to the right of line A-A, except that the door at the left end of the heating chamber is replaced by a solid wall. Ground door frames and door plates practically eliminate leakage. Standard baskets are used, so load can be completely processed from a hardening or case hardening treatment through washing and bright tempering or controlled oxidation operations without removing them from the baskets. Baskets are moved from place to place by roller-conveyers which are swiveled to change the direction of movement. When separate units — wash, heat treatment, bright tempering — are combined in one assembly line, an extremely compact system results.

The longitudinal section shows the forced convection-type system of atmosphere circulation. An alloy fan circulates the atmosphere continuously through the electrical heating element and then through the load. Unusually uniform temperatures are maintained throughout the load. The heating element is designed for easy replacement and is electrically rated for rapid recovery when a cold load is charged.

When this unit is used with an endothermic controlled atmosphere, either bright tempering or controlled oxidation can be done. The endothermic atmosphere is maintained during the entire heating and cooling cycle of a bright tempering operation, and the moisture is controlled at a dew point suitable for the composition of the steel and the temperature. Work is cooled in the furnace to about 400° F., and remains bright while cooling further in open air.

If a slight blue temper color is not objectionable, the load can be removed somewhat hotter than 400° F. and either cooled in air or quenched. As indicated earlier, if a load is cooled in air from as much as 700° F.,

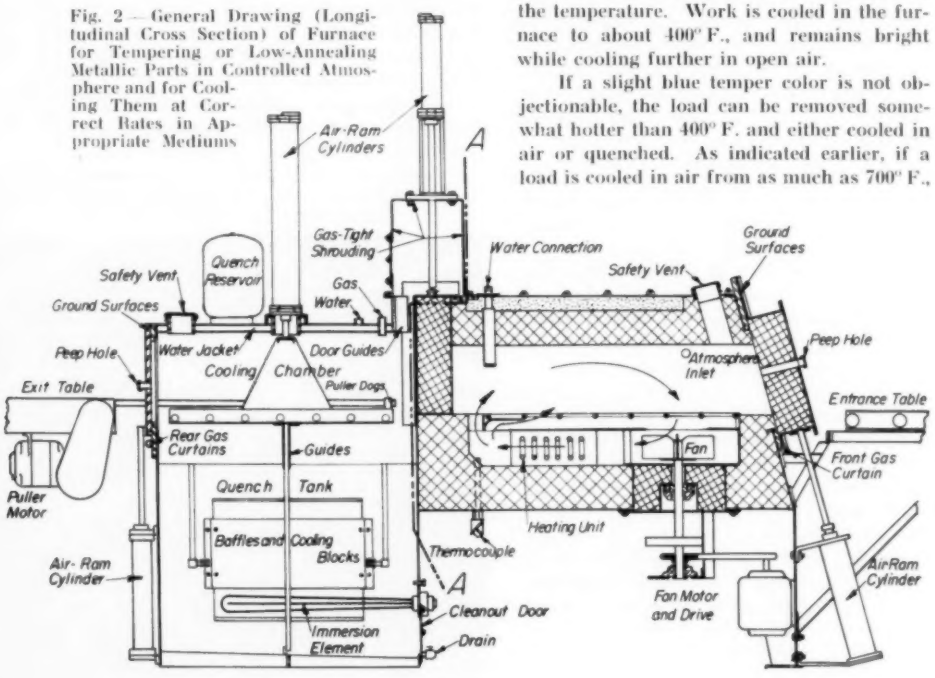

Fig. 2 — General Drawing (Longitudinal Cross Section) of Furnace for Tempering or Low-Annealing Metallic Parts in Controlled Atmosphere and for Cooling Them at Correct Rates in Appropriate Mediums

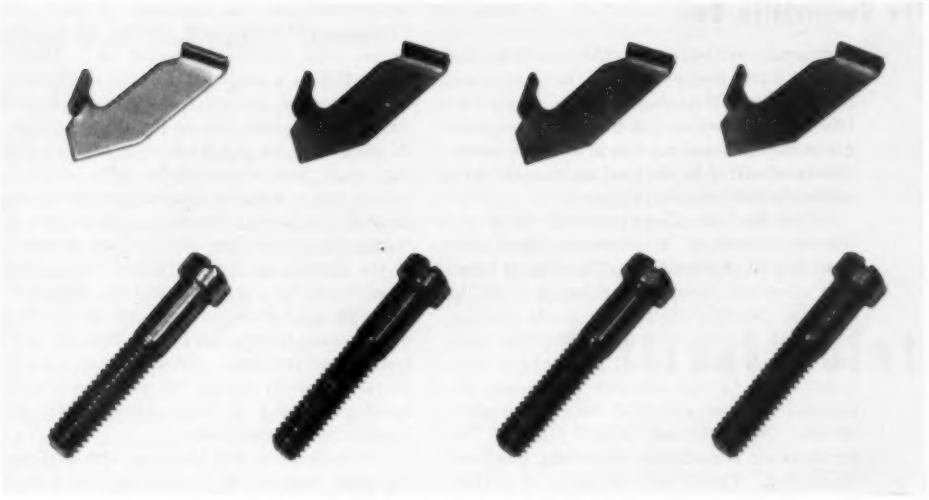

Fig. 3 — Stampings Made From A.I.S.I. 1010 Steel and Cap Screws Made From C-1038, As-Received and After Controlled Oxidation in Moist Atmosphere for 15 Min. at 1000° F. Previous tempering or annealing was 1 hr. at 1000, 1200 and 1400° F.

only superficial oxides or temper colors will form. Even this effect would be minimized if liquid quenching were permissible. For many applications slightly colored surfaces made by one of the above methods would be completely satisfactory; however, the opportunity always exists of producing absolutely bright work when it is preferable.

Capacity of such an in-and-out furnace, well insulated, is restricted by the time required for the furnace and load to cool from heat treating temperature to safe removal temperature. Hence the draw-quench ("DQ") combination shown in Fig. 2 and described at some length later on.

When the "D" unit is used for controlled oxidation, an endothermic atmosphere is used during the heating cycle and also for a prior tempering or annealing operation, if desired. If clean work is merely to be colored, the atmosphere is maintained until 750 to 1060° F. is reached. In work which does not require the best possible oxide coating, temperatures approaching 1400° F. have been found satisfactory when time at that temperature is not too great.

After the load has reached selected temperature, the flow of endothermic gas to the furnace is discontinued and a measured quantity of water is led into the furnace at a controlled rate. Thickness of the magnetic oxide coating is controlled, within useful limits, by control of time, temperature and moisture during this portion of the cycle. The articles are then removed from the furnace and either cooled in air or liquid quenched. While air cooling, the articles are protected against further extensive oxidation by the oxide coating already formed in the furnace. The result is a tenacious oxide coating with a pleasing appearance.

Oil quenching results in a darker appearance due to the oil in the film. This coating is usually regarded as more pleasing in appearance and it has the additional advantage of being considerably more resistant to corrosion. Either soluble oil or standard quenching oil can be used for the quench.

TREATMENT FOR CONNECTING RODS

Figure 3 shows some finished work but the process is by no means limited to small parts. For example, the standard basket holds 260 lb. of forged connecting rods made of S.A.E. 1045; they are first bright hardened by heating to 1550° F. and quenching in oil at 125° F. to Brinell 380 to 429. The entire basketload is then moved on a roller-conveyer to an Ipsen W-300 washer unit which removes the quenching oil by a single-stage dip wash. The load is next conveyed to a D-300 tem-

The Combination Unit

pering unit maintained at 1200° F. After the load reaches temperature, it is maintained for 1 hr., and then cooled in the furnace to 1000° F. The flow of endothermic atmosphere gas is then discontinued and water is immediately admitted to the heating chamber at a predetermined rate for 10 min.

The load is then removed from the furnace, conveyed to a quench tank and quenched in standard oil. The Brinell hardness after this complete treatment is 207 to 217. A pleasing dark blue oxide coating covers all surfaces of the connecting rods and protects them against atmospheric corrosion until further machine operations, assembly, and an extended time in normal service. Sand-blasting, which followed the previous air atmosphere tempering, has been eliminated. Controlled oxidation is preferable to bright tempering because if there is a time lag in machining and assembly, bright tempered rods would rust.

Figure 3 compares the results of three oxidation cycles and the appearance of the material as received. The heat treatments were carried out at 1000, 1200 and 1400° F., respectively, for 1 hr., followed by furnace cooling to 1000° F. and then a 15-min. controlled oxidation cycle in a water atmosphere. These parts were removed from the furnace and oil quenched; air-cooled samples gave practically identical results.

Series "DQ" Tempering Units (Fig. 1 and 2) are fully automatic, sealed units including a heating chamber separated from a combination cooling chamber and quench tank by an inside door. A controlled endothermic atmosphere exists in both heating and cooling chambers, insuring that the parts being treated will not contact air at any time during heat treatment.

Details of the heating chamber and entrance door are practically identical to those of the "D" units described above. The quench tank is equipped with heating elements and cooling coils for automatic control of the temperature of the quenching medium; the temperature of the water-jacketed cooling chamber is separately controlled, also automatically. Quenching medium is circulated by two two-speed motor-driven propellers. Sealed doors at front and rear have flame curtains to eliminate air infiltration during charging and discharging.

The "DQ" units are completely automatic and can be operated through any program of heating and cooling by electric timers and selector switches in a circuit controlled by a single start button. The only labor required is to push loaded baskets into the heating chamber from the entrance table. At the end of the pre-set heating and tempering cycle the intermediate alloy door is raised and a transfer mechanism, operating through the cooling chamber, reaches in and moves the basket into the cooling chamber. If the load is to be air cooled, the basket remains in the cooling chamber. However, if the set cycle includes a quench, an elevator immediately lowers the basket into the tank for the correct time. Circulation of quench is automatically timed for either available speed; the load is then raised ready for transfer to the exit table.

It is obvious that this unit can perform the same tasks as the in-and-out batch unit described in the first part of this article. The former is recommended for bright tempering at intermediate production rates, the "draw-quench" unit for high rates of production since no furnace cooling is required —even from the higher tempering temperatures. A new load can be charged into the heating chamber as soon as the previous load is pulled from the heating chamber into the cooling chamber.

When these high-production units are used for controlled oxidation the choice of air cooling or liquid quenching still exists. (As already described, when a blued finish is desired the work and furnace are cooled to, say, 1000° F., the input of gas stopped, a measured amount of water gradually introduced, and within 10 to 15 min. the work is ready for transfer into the cooling chamber.) Quenching is automatic within the unit. Work and baskets are cool when finally removed from the cooling chamber. Consistent work is more easily produced when time and quenching cycles are automatically controlled. Identical settings on the control panel will consistently duplicate the results obtained previously with trial loads or with former production runs.

Adaptability to Nonferrous Metals — In addition to the applications mentioned, the treatment of many nonferrous metals is possible. For example, the solution heat treatment of aluminum, the annealing of copper or brass, and the precipitation or solution heat treatment of beryllium copper can all be carried out in this equipment.

Critical Point

BY THE EDITOR

Making Good Toolsteel at Latrobe

TO PITTSBURGH, after too long a lapse, to find handsome new buildings all over the place, many using much stainless steel for exterior shell — "curtain wall", is the architect's term — and fell to wondering how all the new tenants would find their way into this area of narrow streets, badly choked with traffic ever since the automobile supplanted the trolley and interurban.

Hospitable Latrobe Steel Co. sent a nice new Cadillac to taxi some of the editor-guests to the plant, 40 miles across charming green hills. Latrobe's staff wanted us to see their latest achievement — a 10-in. bar of tungsten-molybdenum high speed toolsteel, 10 ft. long and weighing 2500 lb. They enthusiastically called it a "perfect" bar — a word so shunned by fussy editors that it should be defined: This bar has no visible surface defects or Magnaflux "indications". It is sound — that is, an ultrasonic reflectoscope tuned to discover any internal discontinuity of 0.0015 sq.in. area shows no "pip" on the oscilloscope no matter where the resonating crystal is placed. Disks cut from the ends, hardened, polished and etched, show no white spots. Maximum variation in composition, edge to center or end to end, is 0.02% C, 0.15% W, 0.12% Mo.

No mean performance, you will admit, and the result of a continued campaign for improved quality instituted by M. W. Saxman, president more than 10 years ago. David Giles, vice-president at the time, believed that most progress could result by controlling the segregation of the complex carbides in both tool and die steels. Progressive consumers of toolsteels had long before pointed out that excessive carbide segregation was the cause of many subsequent troubles like forging bursts, erratic machinability, irregular hardenability and warpage, and variable performance of tool or die. However, the suppression of this perfectly natural phenomenon was something else again. Nevertheless, by 1945 Giles was able to produce consistently average-sized bars and blocks of notably uniform macrostructure. Of recent months the same metallurgical control has been extended to much larger masses.

S. G. Fletcher, now Latrobe's chief metallurgist, showed the Editor the melt shop without disclosing the answer to the $64 question, "How is it done?" Without snooping about to discover the answer, many items of good steelmaking practice, widely recognized as such, were noted: All the small scrap, both own and purchased, is melted, well blown with oxygen, refined, and cast into small blocks of known chemical composition, free of the hydrogen which would inevitably enter metal made from oily waste, and tend to cause "flakes" or forging bursts. Temperature of molten steel is measured before tapping and during teeming. Open ended ingot molds are fairly short and fat and are set on copper stools. Pipe is prevented by Kellogg equipment which plays an electric arc on the ingot top. (Each of the 30 stations is served by its own Lincoln arc welding generator.) Ingots are cogged before going cold; all such billets must pass ultrasonic tests for internal soundness before further work, and before any unrecorded irregularity in production routine is forgotten. Decarburized surface is ground off before finish rolling. Each end of each finished bar is sawed off, the disks ground, etched and inspected for center segregate and "decarb" before shipment.

It is impossible to resist speculation as to how the distribution of carbides can be controlled. As a matter of fact, segregation is causing trouble in other metal products — especially complex castings and heavy steel forgings — and if the Latrobe method has any generality, it could usefully be installed by foundrymen and tonnage steelmakers. Two general principles are known to the Editor, who makes no claim to omniscience: One casts metal slowly, just as fast as it solidifies, but there is no elaborate ingot-pit equipment at this plant in Latrobe. The other scheme is to introduce inoculants of some sort, either from the slag during high-temperature refining or designedly added as a pinch of something — sodium, calcium, aluminum, titanium (?) — which forms a harmless minor constituent that freezes almost simultaneously with the iron in a cloud of particles capable of seeding the immediate crystallization of carbide.

Advertisement

ELECTROMET *Data Sheet*

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ALLOYS FOR THE STEEL, IRON, AND NON-FERROUS INDUSTRIES

BORON ALLOYS

PRODUCT*	NOMINAL COMPOSITION	USES
Ferroboron		
Min. 10.00% Boron Grade	Silicon.....max. 1.50% Aluminum.....max. 0.50% Carbon.....max. 1.50%	Increases hardenability of steel; also, for additions to malleable iron and aluminum alloys.
Min. 17.50% Boron Grade	Silicon.....max. 1.50% Aluminum....max. 0.50% Carbon.....max. 0.50%	
Manganese-Boron	Boron.....min. 17.50% Manganese...approx. 75% Silicon.....max. 1.50% Carbon.....max. 3% Iron.....max. 5%	Used to cleanse and deoxidize non-ferrous alloys.
Nickel-Boron	Boron.....15 to 18% Silicon.....max. 1.50% Aluminum.....max. 1.00% Carbon.....max. 0.50% Iron.....max. 3.00% Nickel.....Balance	Special boron alloy used principally for deoxidizing nickel and its alloys.
Boron Carbide	Boron.....45 to 50% Carbon .....45 to 50%	Deoxidizer for non-ferrous alloys.
Calcium Boride	Boron.....38 to 42% Calcium.....27 to 32% Carbon.....15 to 20%	Welding rod coating.

CALCIUM ALLOYS

Calcium-Silicon	Calcium.....30 to 33% Silicon.....60 to 65% Iron.....1.50 to 3%	Deoxidizer for quality ingot steel. Also used in high-tensile gray irons.
Calcium-Manganese-Silicon	Calcium.....16 to 20% Manganese.....14 to 18% Silicon.....53 to 59%	A complex deoxidizer used widely in production of steel castings.
Calcium Metal		Reducing agent in metallurgical applications, deoxidizer and degasifier for non-ferrous metals, particularly magnesium.
Regular Grade	Calcium.....98% (Cylinders, Slabs, Cut Pieces, or Turnings)	
Distilled Grade	Calcium...approx. 99.90% (Irregular pieces from pea size to 14 in. lumps)	For special applications requiring calcium of very high purity.

CHROMIUM ALLOYS

Low-Carbon Ferrochrome	Chromium.....67 to 71% Silicon.....0.30 to 1.00% Carbon (10 Grades) max. 0.03 to max. 2.00%	Production of stainless steels and high-temperature alloys requiring low carbon content.
High-Carbon Ferrochrome		
Max. 4.50, 5.00, or 6.00% Carbon Grade	Chromium.....67 to 70% Silicon..... 1 to 2%	For production of engineering alloy steels and other alloy steels of moderate chromium content.
Max. 7.00% Carbon Grade	Chromium.....66 to 69% Silicon..... 1 to 3%	
Min. 7.00% Carbon Grade	Chromium.....65 to 68% Silicon..... 1 to 3%	
Nitrogen-Bearing Low-Carbon Ferrochrome	Chromium.....67 to 71% Silicon.....0.30 to 1.00% Carbon.....max. 0.10% Nitrogen....approx. 0.75%	For additions of nitrogen to improve properties of high-chromium steels.
"SM" Ferrochrome	Chromium.....60 to 65% Silicon ..... 4 to 6% Carbon..... 4 to 6% Manganese..... 4 to 6%	A high-solubility chromium addition for steel or iron in either furnace or ladle.
Exothermic Ferrochrome	Chromium....60% approx. Carbon.....4.5% max.	An improved exothermic ladle alloy with high solubility, low carbon pickup, and high ignition temperature.
Exothermic Silicon-Chrome	Chromium...46% approx. Silicon..... 23% approx. Carbon.....1.00% max.	An improved exothermic ladle alloy with high solubility, very low carbon pickup, and high ignition temperature.

CHROMIUM ALLOYS cont.

Foundry Ferrochrome	Chromium.....62 to 66%	
High-Carbon Grade	Silicon..... 7 to 10% Carbon..... 5 to 7%	Developed especially for high-solubility ladle additions of chromium to improve composition and properties of cast iron.
Low-Carbon Grade	Chromium.....50 to 54% Silicon.....28 to 32% Carbon.....max. 1.25%	
Chromium Metal	Chromium.....min. 97%	
Low-Carbon Grades	Carbon .....max. 0.10% and 0.50% Iron.....max. 1%	Production of wide variety of non-ferrous chromium-bearing alloys, including electrical resistance alloys and high-temperature alloys.
High-Carbon Grade	Chromium.....87 to 90% Carbon..... 9 to 11% Iron.....max. 1.25%	
"EM" Ferrochrome-Silicon	Chromium.....39 to 41%	
No. 1 Grade	Silicon.....42 to 46% Carbon.....max. 0.05%	In production of stainless steels, these alloys are used to reduce metal oxides from the slag back into bath.
No. 2 Grade	Chromium.....36 to 39% Silicon.....36 to 39% Carbon.....max. 0.05% Aluminum..... 7 to 9%	
"EM" Ferrosilicon-Chrome	Chromium.....50 to 54% Silicon.....28 to 32% Carbon.....max. 1.25%	For adding chromium and silicon to steels containing up to 1 or 2 per cent chromium.
"EM" Chromium Briquets (Hexagonal Shape)	Chromium.....2 lb. Total Weight.....3½ lb.	For adding chromium to cast iron in the cupola.

COLUMBIUM ALLOYS

Ferrocolumbium	Columbium.....50 to 60% Silicon.....max. 8% Carbon.....max. 0.40%	Stabilizer in austenitic chromium-nickel stainless steels. Also constituent of high-temperature alloys.
Ferrotantalum-Columbium	Columbium...approx. 40% Tantalum....approx. 20% Cb+Ta .....min. 60% Silicon.....4 to 6% Carbon.....max. 0.30%	Another stabilizer, used to supplement ferrocolumbium, in austenitic chromium-nickel stainless steels. Also used in high-temperature alloys.

MANGANESE ALLOYS

Standard Ferromanganese	Manganese.....78 to 82% Carbon.....approx. 7%	Most common means of adding manganese to steel for both alloying and deoxidizing purposes. Also for counteracting sulphur in steel and cast iron.
Regular Grade	Silicon.....max. 1%	
Low-Phosphorus Grade	Manganese.....78 to 82% Carbon.....max. 7% Silicon.....max. 2% Phosphorus...max. 0.10%	
Low-Carbon Ferromanganese	Manganese.....min. 90% Carbon.....max. 0.07%	
Low-Phosphorus Grade	Phosphorus...max. 0.06%	Additions of manganese to steels of low-carbon specification, particularly stainless steels of 18 per cent chromium, 8 per cent nickel type.
Regular Grades	Manganese.....85 to 90% Carbon ....max. 0.07, 0.11 to 0.15, 0.30, or 0.50%	
Regular Grade (High-Silicon)	Manganese.....80 to 85% Carbon.....max. 0.75% Silicon..... 5 to 7%	
Medium-Carbon Ferromanganese	Manganese.....80 to 85% Carbon.....max. 1.25 to 1.50%	For making low- and medium-carbon manganese steel and Hadfield steel.
Silicomanganese		
Max. 1.50% Carbon Grade	Manganese.....65 to 68% Silicon.....18 to 20%	A versatile alloy useful as furnace block, deoxidizer, and also for making manganese additions to steel in the ladle or in the furnace.
Max. 2.00% Carbon Grade	Manganese.....65 to 68% Silicon.....15 to 17.50%	
Max. 3.00% Carbon Grade	Manganese.....65 to 68% Silicon.....12 to 14.50%	

*All of the alloys and metals listed are produced in the usual lump, crushed, or ground sizes, except where other special forms are indicated.

PRODUCT*	NOMINAL COMPOSITION	USES
MANGANESE ALLOYS cont.		
Low-Iron Ferromanganese	Manganese.....85 to 90% Carbon.....approx. 7.00% Silicon.....max. 3% Iron.....max. 2%	For high manganese additions to certain non-ferrous alloys, particularly aluminum.
Manganese Metal	Manganese.....min. 96% Carbon.....max. 0.20% Silicon.....max. 1.00% Iron.....max. 2.50%	Used both as deoxidizer and alloy in production of numerous non-ferrous metals and alloys.
"EM" Silico-manganese Briquets (Square Shape)	Manganese.....2 lb. Silicon.....½ lb. Total Weight.....3½ lb.	For adding manganese (with silicon) to cast iron in the cupola.
"EM" Ferro-manganese Briquets (Oblong Shape)	Manganese.....2 lb. Total Weight.....3 lb.	For adding manganese (without silicon) to cast iron in the cupola.
SILICON ALLOYS		
50% Ferrosilicon		
Regular Grade	Silicon.....47 to 51%	Deoxidizer for most grades of killed or semi-killed steel. Blocking grade specially sized for maximum efficiency.
Blocking Grade	Silicon.....47 to 51%	
Low-Aluminum Grade	Silicon.....47 to 51% Aluminum.....max. 0.40%	
65% Ferrosilicon		
Regular Grade	Silicon.....65 to 70%	For furnace or ladle addition to carbon and alloy steels.
Low-Aluminum Grade	Silicon....61.50 to 66.50% Aluminum.....max. 0.50%	Mainly for production of electrical sheet steel.
75% Ferrosilicon		
Regular Grade	Silicon.....73 to 78%	Deoxidizer and alloy for production of high-silicon spring and electrical sheet steel. Graphitizing inoculant for cast iron.
Low-Aluminum Grade	Silicon.....73 to 78% Aluminum.....max. 0.50%	
85% Ferrosilicon		
Regular Grade	Silicon.....83 to 88%	Enables melter to add higher percentages of silicon without chilling metal in ladle. Graphitizing inoculant for cast iron.
Low-Aluminum Grade	Silicon.....83 to 88% Aluminum.....max. 0.50%	
90% Ferrosilicon		
Regular Grade	Silicon.....92 to 95%	Permits large additions of silicon without harmful chilling effect.
Low-Aluminum Grade	Silicon.....92 to 95% Aluminum.....max. 0.50%	
Silicon Metal		Additions of silicon to non-ferrous metals, particularly aluminum and copper, to improve physical properties.
Regular Grade	Silicon.....min. 97 or 96% Iron.....max. 1 or 2%	
Purified Grade	Silicon....99.70 to 99.90% Iron.....005 to .015%	For applications in non-ferrous industry requiring silicon of high purity.
Low-Calcium Grade	Silicon.....min. 97% Iron.....max. 1% Calcium.....max. 0.10%	For the production of high-silicon aluminum alloys where calcium is detrimental.
Low-Aluminum Grade	Silicon.....min. 98% Iron.....max. 1% Aluminum.....max. 0.10%	For the production of silicon-copper alloys where aluminum is detrimental.
"SMZ" Alloy	Silicon.....60 to 65% Manganese..... 5 to 7% Zirconium..... 5 to 7%	Particularly strong graphitizing inoculant used in making ladle additions to cast iron.
Special Graphitizer	Ferrosilicon Compound	Deoxidizer and graphitizer for cast iron.
Magnesium-Ferrosilicon	Silicon.....approx. 46% Magnesium..approx. 8.5%	For ladle addition to cast iron to obtain special properties.
Barium-Silicon	Barium.....40 to 50% Silicon.....45 to 55%	For deoxidation of non-ferrous alloys.
"EM" Silicon Briquets (Cylindrical Shape)		
Large Size	Silicon.....2 lb. Total Weight.....5 lb.	For adding silicon to cast iron in the cupola.
Small Size	Silicon.....1 lb. Total Weight.....2½ lb.	

"Electromet," "EM," "SM," and "SMZ," are trade-marks of Union Carbide and Carbon Corporation.

PRODUCT*	NOMINAL COMPOSITION	USES
TITANIUM ALLOYS		
Ferrotitanium	Titanium.....27 to 32% Carbon .....max. 0.10%	For stabilized austenitic stainless steels and high-temperature metals.
Silicon-Titanium	Titanium.....40 to 50% Silicon.....45 to 50% Iron.....max. 3%	For additions of titanium to steels or non-ferrous alloys.
Manganese-Nickel-Titanium	Titanium.....43 to 48% Nickel.....approx. 25% Manganese.....max. 8%	Deoxidization of nickel alloys.
TUNGSTEN ALLOYS		
Ferrotungsten	Conforming to A.S.T.M. Spec. A 144-39	For production of tool and die steels; also high-temperature alloys.
Tungsten Metal Powder		Production of tungsten steels and cast tungsten carbide.
Melting Grade	Tungsten.....min. 98.80% Total Carbon..max. 0.25%	
Calcium Tungstate	Tungstic Oxide..68 to 72%	For making tungsten chemicals and other tungsten products.
Calcium Tungstate Nuggets	Tungstic Oxide..68 to 72%	Making tool steels and high-temperature alloys by direct reduction.
Ammonium Paratungstate	Tungstic Oxide..min. 88.7%	Intermediate for tungsten products.
VANADIUM ALLOYS		
Ferrovanadium	Vanadium.....50 to 55% Carbon....max. 0.20, 0.50, or 3.00% Silicon....max. 1.50, 2.00, or 8%	Production of tool and engineering steels, high-strength structural steels, non-aging rimming steels, and wear-resistant irons.
Vanadium Oxide Fused	V_2O_5.....86 to 89% Na_2O.....approx. 10% CaO.....approx. 2%	For addition of vanadium to steel and for manufacturing catalysts.
Sodium Polyvanadate (Red Cake)	V_2O_5.....approx. 85% Na_2O.....approx. 9% CaO.....approx. 2% H_2O.....approx. 2.5%	For manufacture of vanadium compounds, including vanadium catalysts.
High-Purity Ammonium Metavanadate	V_2O_5.....approx. 99.50% NH_4VO_3.....min. 99%	
ZIRCONIUM ALLOYS		
12 to 15% Zirconium Alloy	Zirconium.....12 to 15% Silicon.....39 to 43% Carbon.....max. 0.20%	This is a powerful deoxidizer. It also increases depth of hardening.
35 to 40% Zirconium Alloy	Zirconium.....35 to 40% Silicon.....47 to 52% Carbon.....max. 0.50%	Deoxidizer for fine grades of alloy steels. Used for adding larger amounts of zirconium.
Nickel-Zirconium	Zirconium.....25 to 30% Nickel.....40 to 50%	For deoxidizing and degasifying nickel alloys.

IF YOU HAVE A METALS PROBLEM

More than 50 different alloys and metals are produced by ELECTROMET in hundreds of varying compositions and sizes. If you need help in selecting the proper alloys, or have some specific metallurgical problem, be sure to consult one of ELECTROMET'S specially trained metallurgists and engineers. Address your inquiries to one of the offices listed below.

Birmingham 3, Ala.....Brown-Marx Building
Chicago 1, Ill.....230 N. Michigan Avenue
Cleveland 14, Ohio.....Union Commerce Building
Detroit 2, Mich.....6-240 General Motors Building
Houston 11, Texas.....6119 Harrisburg Boulevard
Los Angeles 58, Calif.....2770 Leonis Boulevard
New York 17, N. Y.....30 East 42nd Street
Pittsburgh 22, Pa.....2207 Oliver Building
San Francisco 6, Calif.....22 Battery Street
In Canada: Electro Metallurgical Company of Canada Limited, Welland, Ontario

Personal Mention

Horace A. Deane

Cyril Stanley Smith

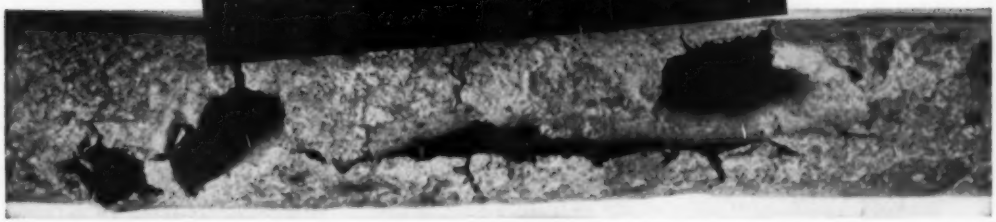
HORACE A. DEANE, long active in foundry circles, has been elected a vice-president of Campbell, Wyant and Cannon Foundry Co., Muskegon, Mich. He was formerly operating vice-president of the Brake Shoe and Castings Division of American Brake Shoe Co., a position he held since 1945. He had been associated with American Brake Shoe for 13 years and had charge of the 17 foundries of that company which are located throughout the United States. Mr. Deane previously held the positions of works manager, district works manager and assistant works manager of the Brake Shoe and Castings Division. Prior to his association with American Brake Shoe, he was with Deere & Co. as assistant chief metallurgist of their foundries. He is a graduate of the University of Illinois and is the author of many technical papers on foundry practices. His professional activities include membership in the American Foundrymen's Society, of which he was national director from 1946 to 1949, and he has served as chairman of the Quad-Cities Chapter (Moline, Ill.) and the Metropolitan Chapter (New York City) of AFS. He is also a past chairman of the Tri-Cities Chapter (Moline, Ill.) of the American Society for Metals.

Clinton F. Zabriskie is now foundry metallurgist with Sperry Gyroscope Co., Great Neck, N. Y.

DR. CYRIL STANLEY SMITH will be awarded the Francis J. Clamer Medal by Franklin Institute for his metallurgical contribution to the development of atomic energy during and since World War II. Dr. Smith is professor of metallurgy and director of the Institute for the Study of Metals at the University of Chicago. Born in Birmingham, England, in 1903, he received his B.Sc. degree from the University of Birmingham. He came to the United States to study at the Massachusetts Institute of Technology, where he was research associate in 1925 and 1926, receiving his D.Sc. degree in 1926. For the next 15 years Dr. Smith was research metallurgist for American Brass Co., where he established a reputation not only as an authority on copper-base alloys but also as a careful scientific investigator of the fundamentals underlying the structure and properties of metals in general. With the entry of this country into the war, Dr. Smith was made research supervisor of the War Metallurgy Committee under the National Defense Research Committee of the National Research Council. In 1942 he was made associate division leader in charge of metallurgy of the Manhattan District, Los Alamos Scientific Laboratory. In 1945 he accepted the position which he still holds at the University of Chicago. He was appointed a member of the general advisory committee to the Atomic Energy Commission in 1946 and continued on this committee until 1951. His most outstanding work was performed as leader in charge of metallurgy of the Manhattan District under an impenetrable veil of secrecy. He was one of the group of scientific workers who mysteriously disappeared into the desert during 1943 and whose work ultimately broke into publicity before a startled world with the news of the explosion of an atomic bomb. Dr. Smith's division, in the words of the 1945 Smyth Atomic Energy report, "was responsible for final purification of the enriched fissionable materials, for fabrication of the bomb core, tamper, and for various other matters". Dr. Smith organized and directed the group of scientists who determined the basic factors in the metallurgy of the two fissionable elements useful in the production of an atomic bomb, that is, uranium 235 and plutonium, the latter being produced by the fission of the former in the presence of uranium 238. Dr. Smith's work on the Manhattan Project earned him the U. S. Medal for Merit. For his earlier work, he received, together with E. W. Palmer, the 1934 Hunt Award from the American Institute of Mining and Metallurgical Engineers. In 1936 he and W. Earl Lindlief received the Institute of Metals Medal from the same society. He has been selected to deliver this year's Edward deMille Campbell Memorial Lecture of the American Society for Metals at the annual Metal Congress in Philadelphia. Dr. Smith is the author of many technical papers and holds a number of patents, mostly on copper and copper-base alloys. He is a member of the American Physical Society, American Academy of Arts & Sciences, History of Science Society, Newcomen Society, American Institute of Mining and Metallurgical Engineers (of which he is past chairman of the Institute of Metals Division), Iron and Steel Institute of London, and of the Institute of Metals of London.

Louis Moses has been transferred to the home office of Bethlehem Steel Co. at Bethlehem, Pa., as mill engineer. "Lou", a writer on rolling mill subjects, was superintendent of the rail mill and the roll department at Sparrows Point, Md., and at Johnstown, Pa.

research at work!



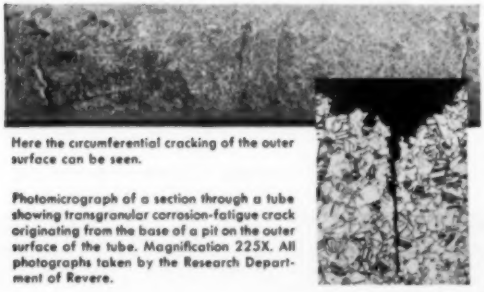
Photograph of a section of a failed tube showing excessive thinning and pitting of the outer surface. Note also the circumferential cracks.

CORROSION STUDIES CAN INCREASE THE ECONOMY OF COPPER ALLOYS

Copper and its alloys are notable for their resistance to corrosion under a wide variety of conditions. There are industrial applications where copper or the appropriate copper alloy should give an indefinitely long life, but where failure because of corrosion may result by reason of unsuitable design of equipment or improper control of environment. Further, there are many situations in which no commercial metal or alloy will have an extended life, but in which copper or one of its alloys possesses a combination of physical and chemical properties which render it the best obtainable material, when all factors, including ultimate costs, are taken into consideration. Hence correct specification becomes of great importance. Recognition of this by industry is responsible for the fact that the Revere Research Department devotes so much time to studying the corrosive effects of fluids and gases, and to preventive measures.

Recently a large manufacturer, who produces condensers as well as other equipment, reported that arsenical Admiralty tubes in a steam-jet ejector were failing after five years. This length of service is not too bad, but nevertheless such tubes often last much longer. Could we make any suggestions?

Seven failed tubes were examined for type of corrosion, metal and scale analysis. The facts were: outer surfaces were badly pitted and grooved with holes completely through in some areas; the inside surfaces were relatively untouched; cracking was circumferential, progressing from the outside; outer scale was largely cupric carbonates and copper sulfide; inner scale was calcium carbonate, cuprous oxide and some iron oxide. Microscopic examination of the cracks showed they originated in corrosion pits on the outside, progressing inward across grain boundaries, rather than along them. The transgranular path of fracture, together with other characteristics of the microstructure, definitely established the fact that the failure was of the corrosion-fatigue type. The corroding pits on the outside created stress concentration points of weakness, from which the cracks originated. Eventually the localized stress exceeded the endurance limit of the metal and it cracked.



Here the circumferential cracking of the outer surface can be seen.

Photomicrograph of a section through a tube showing transgranular corrosion-fatigue crack originating from the base of a pit on the outer surface of the tube. Magnification 225X. All photographs taken by the Research Department of Revere.

The conclusion was, therefore, that damage was from two sources—the first being excessive carbon dioxide and the other non-condensable gases in the steam, which caused the excessive pitting and thinning. It is not unusual to have these and other corrodants present in damaging amounts in the air-ejector system, whereas they are not injurious elsewhere. The second cause of failure was excessive vibration somewhere in the unit which was responsible for the corrosion fatigue failure.

RECOMMENDATIONS. The copper-base tube alloy that generally possesses the greatest resistance to the non-condensable gases responsible for the corrosion of the Admiralty tubes is 5% aluminum bronze. Re-tubing with this was suggested. It was also recommended that steps be taken to effect a material reduction in tube vibration by placing a baffle in the steam inlet. In addition, it was pointed out that many operators find it good practice to discharge the after-condenser drain to the sewer instead of returning it to the system. By this means, the amount of carbon dioxide, ammonia and other gases in the system can be substantially decreased.

* * *

It is interesting to note that the Revere Research Department, located in Rome, N. Y., was able to determine these causes and suggest remedies without ever having seen the condenser. This is the result of modern equipment, and long experience in studying the problems of corrosion. If you have a problem regarding the corrosion of copper and copper alloys, or aluminum alloys, why not take it up with the nearest Revere office? Remember, corrosion that is too rapid wastes both your money and our national resources.

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Personals

Raymond H. Oberdick, Jr., graduated from Pennsylvania State College in June and is now participating in the chemical and metallurgical engineering training program of General Electric Co.

Robert Eidam has accepted a position as metallurgist with American Steel Foundries, Hammond, Ind. He received his degree in metallurgical engineering from Purdue University this summer.

S. M. Naim has joined Tata Iron & Steel Co., Ltd., India, upon his return from the U. S. where he did practical and academic work. He was employed with Precision Metalsmiths, Inc., Cleveland, while in this country.

August R. Ryan has been named manager of sales for furnaces and associated equipment of General Electric's industrial heating department, Schenectady, N. Y. Mr. Ryan has been with General Electric since 1927 when he began as a test engineer.

Dan Reebel has been appointed manager of advertising and public relations at Kennametal, Inc., Latrobe, Pa. He was formerly Pittsburgh editor of all Penton publications and previous to that was associate editor of *Steel*.

M. E. Merchant, senior research physicist at Cincinnati Milling Machine Co., was elected president of the American Society of Lubrication Engineers at its last annual meeting. Formerly A.S.L.E. regional vice-president, he has been associated with the research department of Cincinnati Milling Machine Co. since 1941. He is author of numerous papers on metal cutting, friction and lubrication.

Edward D. Wiard, district manager at Detroit of the Illinois Tool Works, was awarded an honorary doctor of mechanical engineering degree by the Lawrence Institute of Technology, Detroit. He is chairman of the Detroit chapter of the American Society of Tool Engineers, secretary of the research and technical committee and the defense consulting committee of the Metal Cutting Tool Institute, and a member of the Engineering Society of Detroit.

Bernard J. Fischer is now associated with Bethlehem (Pa.) Steel Co., as a metallographic investigator.

Richard K. Wuerfel, formerly metallurgist for National Induction Heating Corp., is now a metallurgist for the induction heating equipment division, Westinghouse Electric Corp., Baltimore.

Earl R. Asch has been appointed senior production process engineer, jet engine section, of Ford Motor Co.'s aircraft engine division.

S. W. Sokolowski has been liaison metallurgist between the Eclipse-Pioneer and Red Bank divisions of Bendix Aviation Corp. during the past year.

Richard J. Herdzik, upon graduation from Grove City College, has accepted a position as production engineer for Sylvania Electric Products Inc., Tungsten Chemical Div., Towanda, Pa.

Vance E. Lambert, formerly research metallurgist with U. S. Steel Co., Kearny, N. J., is now an engineer in the special molybdenum products division of the Westinghouse Electric Corp., Bloomfield, N. J.

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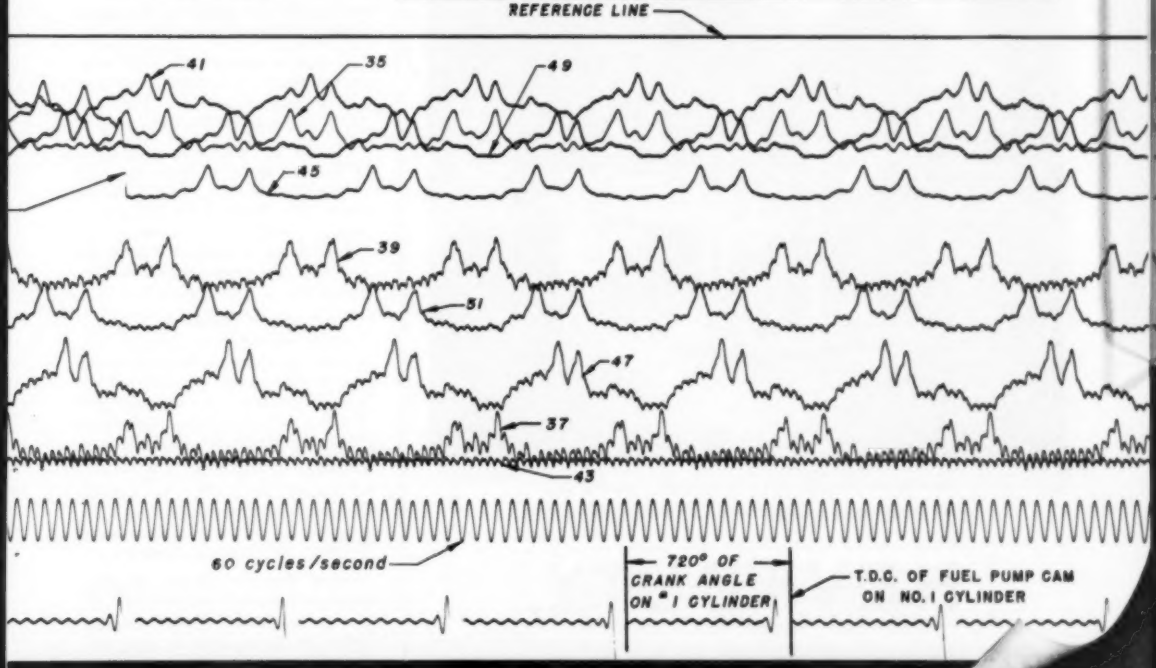

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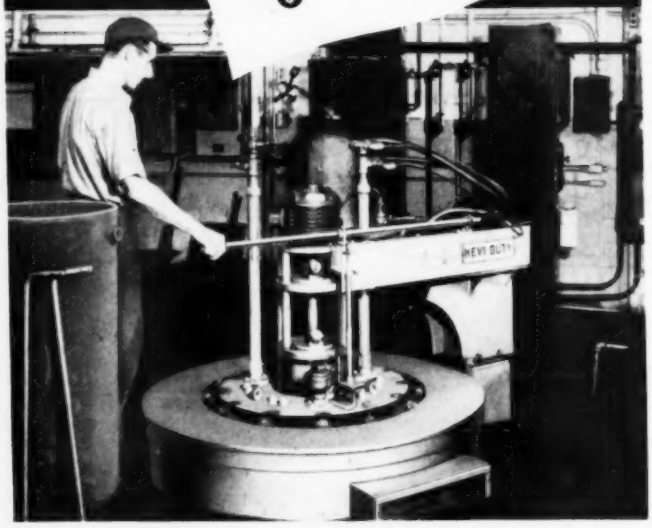

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Personals

Jerome Lee Hoffman has completed the college graduate training program and is now an engineer in the metallurgical department, Caterpillar Tractor Co., Peoria, Ill.

Stanley J. Noesen has completed General Electric Co.'s chemical and metallurgical engineering training program and has taken a permanent position with G. E.'s Knolls Research Laboratory, Schenectady, N. Y.

E. F. Barnes is process metallurgist at the Fairless Works, U. S. Steel Co., Morrisville, Pa.

John A. Alexander graduated from Montana School of Mines in June with a B.S. degree in metallurgical engineering and is now a foreman in the inspection department, American Smelting & Refining Co., Baltimore, Md.

S. J. Sindeband, executive vice-president of Mercast Corp., New York, and president of its licensee, Alloy Precision Castings Co., Cleveland, spent the month of August abroad studying European production problems.

Lloyd J. Bohan is now sales representative in Southern California and Nevada for Michigan Steel Casting Co., Detroit.

David A. Garden and **Miles O. Weaver** have joined the staff of the Electromagnetic Separation Plant, Oak Ridge, Tenn., an atomic energy installation operated by the Carbide & Carbon Chemicals Co., Div. of Union Carbide & Carbon Corp.

Arthur J. Williams, formerly welding engineer at Battelle Memorial Institute, Columbus, Ohio, is now employed as a welding research engineer at Consolidated Western Steel Corp., Maywood plant, Los Angeles.

James B. Love, formerly a laboratory technician at Climax Uranium Co., is now assistant metallurgist for Denver & Rio Grande Western Railroad Co., Denver.

L. H. McCreery has resigned as chief materials and process engineer at McDonnell Aircraft Corp., St. Louis, and is now employed as special projects metallurgist at Bohn Aluminum & Brass Co., Adrian, Mich., at the former Air Force experimental methods plant.

Personals

A. J. Terry Brown, Jr., is now employed as a junior engineer with Fluor Corp., Ltd., Los Angeles, stationed on a construction project in East Alton, Ill.

Eugene B. Moore, recently graduated from the University of Cincinnati, has taken a position as technical engineer with International Business Machines, Inc., Endicott, N. Y.

William R. Smith has accepted a position as welding engineer for General Electric Co., Applied Research Unit, Hanford Works, Richland, Wash.

Q. R. Bowman is now employed as a metallurgist at A. V. Roe (Canada) Ltd., Malton, Ontario. He graduated from McGill University this year, receiving a bachelor of engineering degree in metallurgy.

William F. Saalbach is now adviser on personnel at Pittsburgh Consolidation Coal Co., Pittsburgh, in the research and development division. He was formerly acting placement director and director of veteran affairs at the University of Pittsburgh.

E. S. Jones, formerly employed as a metallurgist with Haynes Stellite Co., Kokomo, Ind., was recently transferred from the General Electric Co.'s Lockland plant to the research laboratory in Schenectady, N. Y.

Norman W. Nielsen is now staff metallurgist at the forge plant of the Vernon Works of Aluminum Co. of America at Los Angeles. He was previously plant metallographer at the Davenport Works.

Joseph A. Palermo, who received a Ph.D. degree in chemical engineering from Syracuse University last June, has accepted a position as research and development engineer with Colgate-Palmolive-Peet Co., Jersey City, N. J.

Vern C. Schmidt, formerly metallurgist at Boeing Airplane Co., Wichita, Kan., is now plant metallurgist and supervisor, airframe division, Hudson Motor Car Co., Detroit.

James J. Barrett has been appointed sales manager of Gemmer Mfg. Co., Detroit. He was previously Detroit representative of Bishop & Babcock Mfg. Co., Cleveland.

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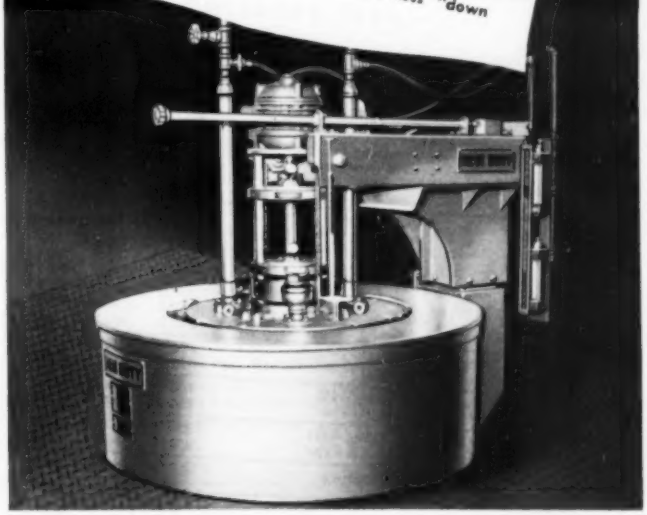

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Personals

John J. Gilman ⊖, who recently received a Ph.D. degree from Columbia University, is now employed at the General Electric Co., Knolls Research Laboratory, Schenectady, N. Y.

Charles R. Simcoe ⊖, formerly with the Atomic Power Div. of Westinghouse Electric Corp. at Pittsburgh, is now a research engineer at Battelle Memorial Institute, Columbus, Ohio.

Philip R. Sperry ⊖ graduated from the University of Notre Dame this year and is now research metallurgist, division of metallurgical research, Kaiser Aluminum & Chemical Corp., Trentwood, Wash. While at Notre Dame he was employed as metallographer on Office of Naval Research projects.

Claren H. Hoehne ⊖ is a metallurgical trainee at Federated Metals Div., American Smelting & Refining Co., Perth Amboy, N. J. He graduated from Texas College of Mines & Metallurgy this year.

Walter M. Hirthe ⊖ is an instructor in the College of Engineering at Marquette University, teaching courses in metallurgy and heat power.

Clyde O. Penney ⊖, who left C. S. Card Iron Works Co., Denver, last February to accept a position as materials inspector with Denver & Rio Grande Western Railroad, has been promoted to metallurgist.

Richard R. Studer ⊖, formerly on the staff of the physics department, Battelle Memorial Institute, Columbus, Ohio, is now metallurgist at Brooks & Perkins, Inc., in their magnesium rolling mill at Livonia, Mich.

Joseph H. Bach ⊖ is now section head, metallurgical research and development, Atomic Energy Division, Sylvania Electric Products Inc., at Bayside, N. Y. He was formerly with General Electric Co., at the Hanford Works, Richland, Wash.

J. F. Butterworth ⊖ has recently taken a position as a metallurgical engineer with Algoma Steel Corp., Ltd., Ontario, Canada.

William E. Taylor ⊖, formerly metallurgist in the solid state division, Oak Ridge National Laboratory, has taken a position as project engineer in charge of solid state research for Motorola, Inc., in their Phoenix, Ariz., research laboratory.

William K. Gibb ⊖ is chief inspector at Atlas Foundry & Machine Co., Tacoma, Wash. Previously he was a metallurgist at the Puget Sound Navy Yard and inspector of castings at Boston Electro Steel Co., Boston.

William F. Davenport ⊖, formerly chief, high temperature alloy unit, materials laboratory, Wright Air Development Center, Wright-Patterson Air Force Base, Dayton, Ohio, has taken a position as metallurgist with Sperry Gyroscope Co., Great Neck, N. Y.

George A. Barker, Jr., ⊖ has resigned as salesman with Bethlehem Steel Co., New York, and moved to Miami, Fla., where he is acting as agent in the southeast for Bowsteel Distributors, Latrobe Steel Co., A. R. Purdy Co., Inc., and Diamond Tool Research Co.

John S. Thompson ⊖, formerly with National Pressure Cooker Co., Eau Claire, Wis., is now research chemist at Westvaco Chemical Div., Carteret, N. J.

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	Neutral "A"	1000°F	1100°F — 1750°F
	Neutral "B"	1200°F	1300°F — 1600°F
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	Neutral "H"	1500°F	1600°F — 1900°F
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	Neutral "AS"	1000°F	1100°F — 1750°F
	Neutral "BS"	1200°F	1300°F — 1650°F
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Personals

Lee R. Standifer, who recently graduated from Ohio State University with a Ph.D. degree in metallurgy, is now in the materials division of the military liaison committee to the Atomic Energy Commission, Washington, D. C.

J. E. Fritts has been transferred from the Columbus (Ohio) plant of Ternstedt Div., General Motors Corp., to the Detroit plant as director of process development.

Mark A. Golik, formerly research metallurgist with Mellon Institute of Industrial Research, Pittsburgh, has accepted a position in the materials application section, Westinghouse Atomic Power Div., Pittsburgh.

John M. Thomas has accepted a position as supervisor of the process metallurgy section, metallurgy department, at Ford Motor Co.'s new scientific laboratory in Dearborn, Mich. He was previously metallurgical engineer with Haskins Mfg. Co., Detroit.

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Paul H. Hausner, upon graduation from the Missouri School of Mines, has accepted a position as metallurgist with General Motors Co., B. O. P. Assembly Div., Kansas City, in the laboratory and development department.

Alvin J. Jacobs is a research engineer in the welding division at Battelle Memorial Institute, Columbus, Ohio.

Sherwood W. McGee received a B.S. degree in metallurgical engineering from the University of Illinois and is now a research assistant for the Armour Research Foundation of Illinois Institute of Technology.

Alvin G. Cook was recently transferred from the forging and casting division of Allegheny Ludlum Steel Corp., Ferndale, Mich., to the extrusion department at Watervliet, N. Y.

Harlan A. Messner was recently appointed west coast manager of Tocco Div., Ohio Crankshaft Co., in charge of a new office in Los Angeles, handling seven western states and British Columbia.

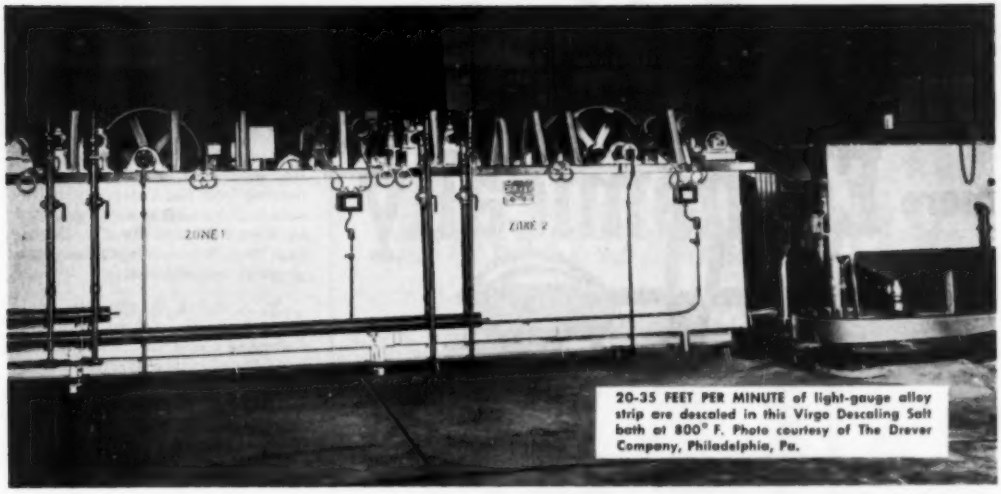
William E. Ray, for the past two years employed at Pennsylvania State College on an Atomic Energy Commission research project, has taken a position with General Electric Co., Hanford Works, Richland, Wash.

Gerald C. Nalon, formerly metallurgical engineer at the Carboloy Dept., General Electric Co., Detroit, has been commissioned in the U. S. Navy and is now on duty as an ordnance engineer at the Naval Ammunition Depot, Hawthorne, Nev.

Andrew S. Yocco, formerly associate physical metallurgist in the research laboratories, Titanium Alloy Div., National Lead Co., has transferred to National Lead Co. of Ohio, Cincinnati, where he is general foreman in metals fabrication plant of feed materials for the Atomic Energy Commission.

Charles W. Lytton has been appointed district sales manager for the Pittsburgh office of Lincoln Electric Co., Cleveland. He was formerly district manager in Buffalo.

John M. Weil has accepted a position as design engineer with International Business Machines Corp., Endicott, N. Y.



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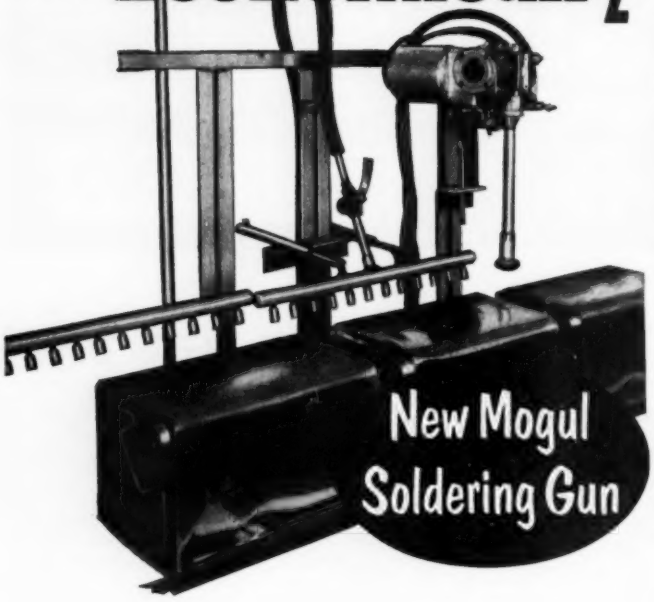

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Personals

Robert J. Christ, upon graduating from the University of Wisconsin, has accepted a position with Deere & Co., Moline, Ill.

Bruce W. Capek received a B.S. degree in metallurgical engineering from the University of Illinois in June and is now employed by Esso Standard Oil Co., Louisiana Div., Baton Rouge, La., as a physical metallurgist.

M. S. Orysh, recently graduated from the School of Mines, Columbia University, has accepted a position as management candidate trainee with U. S. Steel Co. at the Fairless (Pa.) Works.

William G. Voorhes, metallurgist for E. I. du Pont de Nemours & Co., Inc., has been transferred from Argonne National Lab., Chicago, to the Savannah River Atomic Energy Project, Dunbarton, S. C., where he is a production supervisor.

Kenneth B. Bruckart has taken a position with International Minerals & Chemical Corp., Phosphate Div., Bartow, Fla., as flotation relief superintendent. He was formerly metallurgist with Fansteel Metallurgical Corp., North Chicago, Ill.

Arthur A. Bauer, who recently graduated from Columbia University with an M.S. degree, is now employed as metallurgist at Battelle Memorial Institute, Columbus, Ohio.

T. M. Blank has been elected vice-president of Carbon Malleable Castings Corp., Lancaster, Pa. He has been plant manager since 1949 and was formerly with Columbia Malleable Div. of Grinnell, Inc., Columbia, Pa.

Robert M. Mousel is a metallurgical engineer in the explosives department, atomic energy department, E. I. du Pont de Nemours & Co., Inc., at the Savannah River plant in Aiken, S. C.

Julius Goldstein has resigned his position with David J. Joseph Co. and is now operating his own scrap nonferrous metal business in Cincinnati, Ohio.

Earl C. Sutherland, formerly with International Business Machines Corp., Endicott, N. Y., is now a metallurgist with Fansteel Metallurgical Corp., North Chicago, Ill.

Personals

E. G. Pierce, formerly assistant professor of chemistry at Westminster College, New Wilmington, Pa., is serving Washington & Jefferson College, Washington, Pa., in a similar capacity during the present school year.

Bernt A. Ruediger has resigned his position at Electro Metallurgical Co., Div. of Union Carbide & Carbon Corp., Niagara Falls, N. Y., to accept a position as metallurgical engineer at American Locomotive Co., Schenectady, N. Y.

William W. Austin, Jr., formerly senior metallurgist with the Southern Research Institute, Birmingham, Ala., has accepted an appointment as associate professor of mechanical engineering and technical director, department of engineering research, North Carolina State College, Raleigh, N. C.

Alvin S. Cohan has been appointed editor of the *Journal of Metals*, official publication of the metals branch of the American Institute of Mining and Metallurgical Engineers. Mr. Cohan, a metallurgical engineer, joined the staff of the *Journal of Metals* in 1950. Previously he had been engaged in research, development, and production on high temperature applications of powder metals.

E. W. Engle has been promoted to the newly created position of product and process engineering manager, engineering staff, Carboloy Dept., General Electric Co., Detroit. **R. A. Canning** has also been promoted to the new position of production engineering manager in the same department.

Donald R. Guthrie has been appointed executive engineer in charge of engineering research at Minnesota Mining & Mfg. Co., St. Paul, Minn. Mr. Guthrie joined the company in 1939 as research chemist. In 1944 he was made a division engineer. In his new position he will organize an engineering research group which will provide specialized engineering assistance to engineers in the company's various product divisions.

Charles E. Bates, metallurgist with Delco-Remy Div., General Motors Corp., at the Anderson, Ind., plants, has been appointed a member of the development staff, engineering department, Delco Battery Operations, Muncie, Ind.

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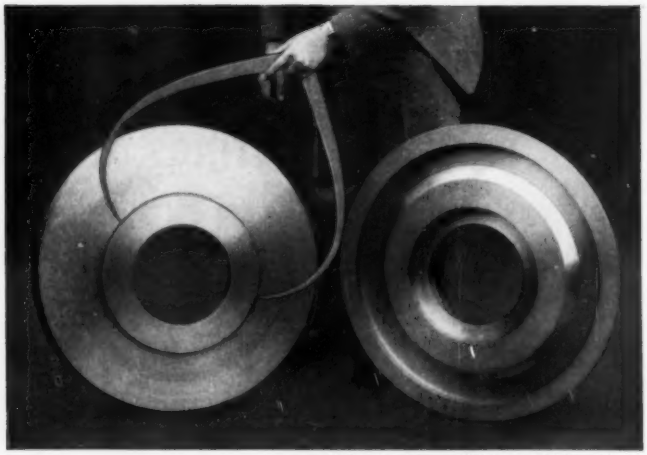

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Alloy Steel Conservation

(Continued from p. 103)

were to be largely increased.

6. With increasing production and decreasing alloy content, current high recoveries from scrap cannot continue. As alloy content continues to drop, the law of diminishing returns will be accelerated. Elements in scrap will be lost because there will be no commercial incentive in their separation.

7. Grade usage is not now a matter of selection of some alloying element because of precedent, but rather is based upon supply of raw material.

Recommendations — In the overall problem, it would be helpful to have more H-steels available. Wider use will do much to circumvent problems concerning residuals.

Additional research should be done on grades likely to replace steels containing high percentages of elements which are now permitted for use in "must" applications: for example, lean steels like 9310, 4815, 46B00, 43BV00, 4340 and 4621.

It might be well to examine all specifications and determine whether grades with small amounts of alloying elements can serve a functional purpose in specific uses, particularly those steels over 0.30% carbon. If not, discontinue their use. It would seem logical to eliminate from the list of standards or tentative standards those steels which are now obsolete.

The facts strongly indicate that this country will be faced with serious problems in alloys when annual steel production, normal or otherwise, exceeds about 90,000,000 ingot-tons, based on present product mix.

If the required conservation is compared with the results obtained, it would be difficult to name the cases where failure in finished parts could be blamed on alternate grades that have been recommended. There have been instances where alternates have been improperly applied and have caused some troubles in fabrication, but none of any consequence where parts made therefrom have failed to function.

It becomes obvious that the constructional alloy steel business has developed grades which are most economical and satisfactory. Therefore, one could logically draw the conclusion that there is sufficient ingenuity left to carry on the one more step, and reach the necessary further conservation without harmful effects.

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MAJOR PRODUCTS ARE IDENTIFIED BY THE FOLLOWING COLORS:

PRODUCT	COLOR	PRODUCT	COLOR
Aluminum	Silver	Ferro Vanadium	Light Blue
Ferro Chromium	Yellow	Grainal	Dark Blue
Ferro Silicon	Red	Noduloy	Green
Ferro Titanium	Orange		

Multiple-element products are identified by combinations of colors. High carbon products are further identified by black squares on top band of the label, and low carbon products are identified by white squares on the top band of the label.

These product-identifying colors are used on drum labels; on car cards for carload shipments; and on tags attached to products shipped in bags.

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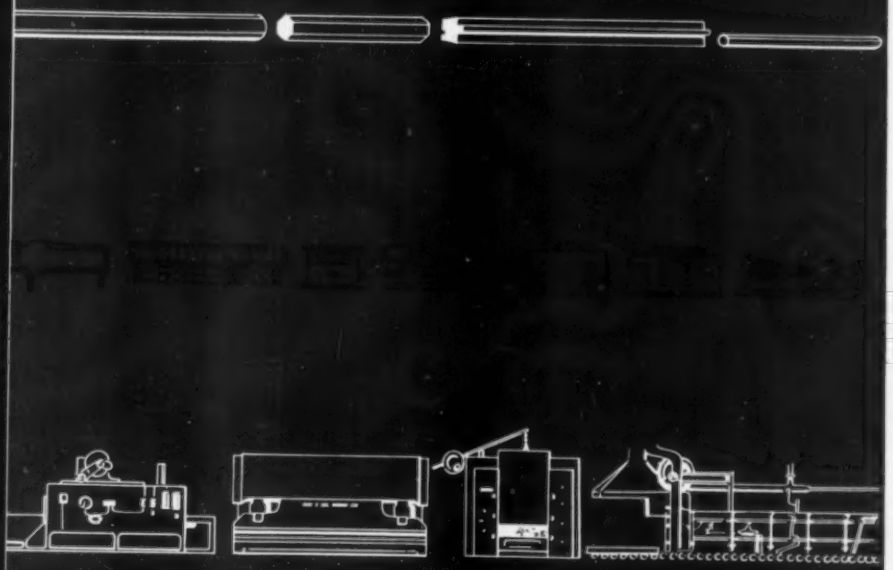

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for SUPERIOR RESULTS

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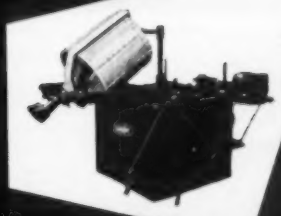

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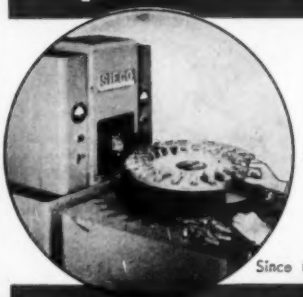

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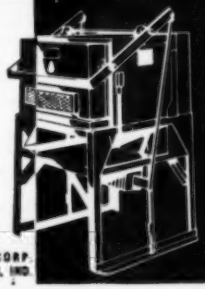

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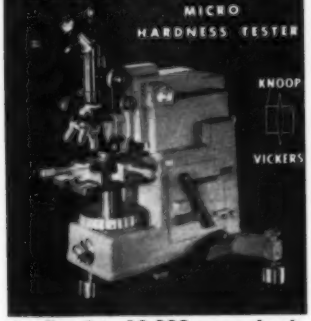

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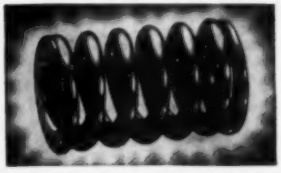

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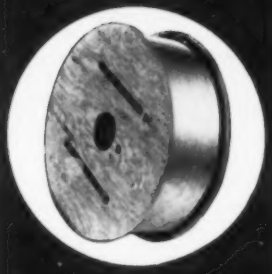

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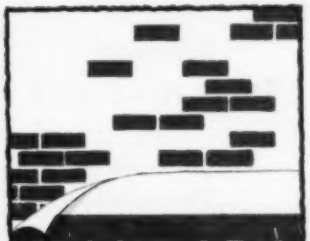

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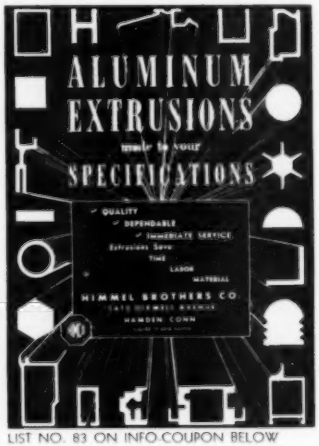

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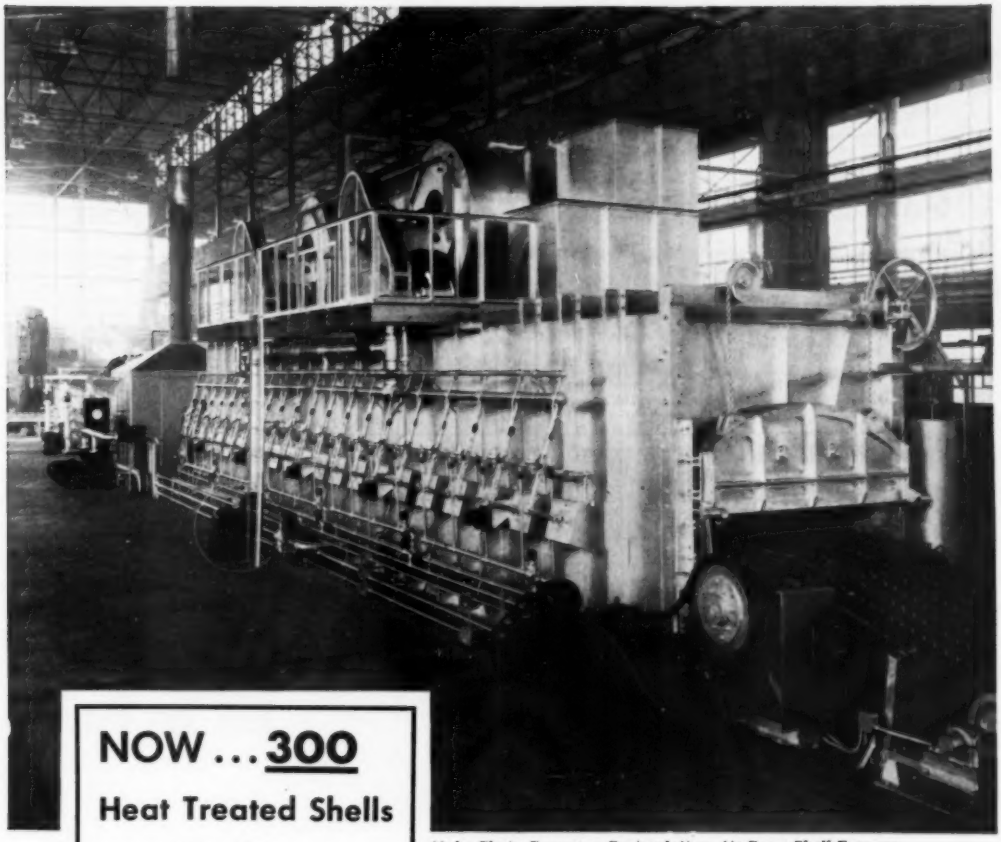

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ALUMINUM SPECIFIED IN NEW TRAILER DESIGN

Butler Aluminum Buildings Considered Wise Investment By Satisfied Owners

Aluminum buildings are enjoying wide popularity in all sections of the country. Proof of this is found in the large scale operations of the Butler Manufacturing Company ... manufacturer of a wide variety of prefabricated buildings for industrial, farm and commercial use ... and a user of Reynolds Aluminum.

Illustrated below is one of the many types of aluminum buildings produced by the Butler Company of Kansas City, Missouri.

This is a 120' x 260' x 14' (multiple 60') building that houses the engineering office of a well known maker of battery plate separators. A similar building, 120' x 260' x 20' is used for manufacturing and warehousing by the same company. Like other owners of Butler engineered buildings, this manufacturer reports complete satisfaction with the aluminum roofing and siding.

Owners of Butler aluminum buildings say they are durable, rustproof, never need painting and require very little maintenance. Occupants also mention that aluminum buildings are more comfortable both in hot and cold weather, because the aluminum so effectively reflects away sun's rays in summer and retains inside heat in winter.

How can the durable, heat reflecting, rustproof, low maintenance qualities of aluminum improve your products? Send for the complete index of Reynolds literature covering all phases of design and fabrication. And, if yours is an architectural application, ask for the Architectural Aluminum Folio. Please request on business letterhead, otherwise the price is one dollar. Write Reynolds Metals Co., 2576 South Third Street, Louisville 1, Kentucky.

Visit The Reynolds Metals Exhibit • Booth No. 1550 National Metal Congress and Exposition Philadelphia • Oct. 18-24

Choice Of Aluminum Pays Dividends In Performance

The Model 130 Tobey Flexi-Truck shown above, illustrates another case where leading design engineers are employing special aluminum extrusions, standard structurals, sheet, castings and other forms of aluminum in new and improved designs.

Aluminum Chuck Offers Definite Advantages in New Screwdriver Kit

This inexpensive Screwdriver Kit is a good example of designing for the best use of each material. Five interchangeable screwdriver blades are steel. The handle is plastic. An all aluminum chuck securely joins handle and blades—provides five screwdrivers in a compact carrying case.

The manufacturer states: "Here are the four basic reasons for using aluminum in the screwdriver chuck: 1. The superior machining qualities of aluminum. 2. Rust protection without special finishes. 3. Positive spring and tension action. 4. Aluminum helped reduce weight.

The Screwdriver Kit is made by Schneider and Shier, Inc., 6457 N. Sheridan Road, Chicago, Ill., prominent manufacturers and distributors of premium promotion items.

In this airline baggage trailer, aluminum structurals and extrusions are used for the bed frame, ends and side gates. The wheels as well as corners for the bed and end frames are aluminum castings. End panels are aluminum sheet and the front hitch is bolted to a structure made of aluminum angle and plate.

The Model 130 is conservatively rated at 3,000 pounds load capacity at 20 miles per hour and, thanks to aluminum, weighs only 430 pounds (approximately). Three empty Flexi-Trucks weigh less than one empty steel trailer of the same size and capacity. Thus more pay load per trailer can be moved safely, with less effort and at higher speeds.

The Flexi-Truck is made by the Tobey Manufacturing Corporation, El Segundo, California, leading designers and manufacturers of light weight, heavy duty material handling equipment. The manufacturer says, "Good construction combined with light, strong resilient aluminum offers warehousemen and material handlers substantial savings through easier operation, greater strength, corrosion resistance, and a durability not to be found in equipment constructed from other materials."

To get similar advantages in your products have a Reynolds Aluminum Specialist work with you on new or redesign problems. This assistance is yours without obligation through the Reynolds office or distributor listed under "Aluminum" in your classified telephone directory. Or, if you prefer, write direct.

For a free copy of the 130 page, 6" x 9" Aluminum Structural Design handbook, and a complete index of other Reynolds literature, write on business letterhead (otherwise price is $1.00) to Reynolds Metals Company, 2576 South Third Street, Louisville 1, Kentucky.

MORE INTERESTING NEWS ABOUT ALUMINUM ON NEXT PAGE

(Advertisement)

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(Continued From Preceding Page)

Baked-on Aluminum Finishes Proving Popular for Nickel and Chrome Replacement

Manufacturers of industrial finishes have developed a baked aluminum finish as a replacement for more expensive nickel and chrome plating, and for other protective and decorative applications. The new finish has good adhesion, is durable and resists salt spray from 250 to 400 hours.

Automotive and Appliance Ornamentation Offers Wide Potential for New Finish.

While each manufacturer varies the process, the same basic procedures usually apply for this new "laminated" aluminum finish. Metal parts are sprayed first with a synthetic high resin primer, then with a slurry of aluminum paste in a special vehicle. Tiny aluminum flakes rise to the surface and are baked in position. Next the parts are sprayed with a clear synthetic lacquer and again baked. The final finish is a virtually solid sheet of aluminum, bake-laminated between two layers of synthetic resin—a tough, attractive, satin lustre finish.

It also is possible to add transparent colors to the final lacquer coat for special decorative effects. In that respect this new finish provides a fresh approach to many old finishing problems.

For the names of manufacturers of this new industrial finish write to Reynolds Metals Company, 2576 South Third Street, Louisville 1, Kentucky.

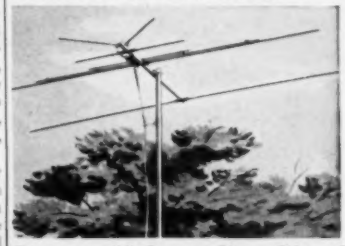
What Is Industry's Biggest Headache?

Did you know that, according to authorities, corrosion is today's biggest headache in industry? Corrosion clips industry to the tune of five and one-half *billion* dollars a year—seven times more than the annual fire losses in the United States. This is just one of the many reasons why more and more corrosion-resistant aluminum is being specified today to help relieve this costly industrial headache.

Volume Producers Benefit With Roll-Formed Aluminum Shapes From Reynolds

Basic structural parts or parts for decorative or functional trim can be quickly and economically roll-formed for your products by Reynolds Parts Division. Many hundreds of standard roll-formed shapes are available without tooling cost thanks to Reynolds tremendous tooling investment. Tooling for special shapes can also be supplied by Reynolds or work can be produced from your rolls on Reynolds roll-form equipment.

Aluminum and roll-forming combine to offer the important benefits of strong, light, uniform shapes that are easily and economically bent, welded, assembled and generally fabricated. Aluminum can be cold roll-formed to close tolerances for your individual product requirements. Natural, embossed, anodized or other finishes are available.



Butt-seam and lock-seam tubing, roll-formed by Reynolds, is widely used in TV antennae.

Whether you make bicycles or baby carriages, metal furniture or fences, television antennae or trucks, window sections or washing machines . . . these and thousands of other products can be produced faster and cheaper in volume by using roll-formed aluminum shapes from Reynolds.

In this connection, it's important to remember that Reynolds Parts Division offers one of the country's most complete facilities for aluminum fabricating in general and includes equipment for shearing, blanking, riveting, welding, forming, finishing and assembly in addition to roll-forming. Reynolds tremendous equipment investment includes hydraulic presses from 300 to 5000 tons, over 100 mechanical presses ranging from 2 to 1700 tons and other big capacity equipment for turning out quality work in large volume.

For complete information on how the Reynolds Parts Fabricating Service can help you or for assistance on your particular requirements, call the Reynolds office listed under "Aluminum" in your classified telephone directory or write Reynolds Metals Company, Parts Division, 2065 South Ninth Street, Louisville 1, Kentucky.

Aluminum Keeps Pace With Modern Trend in Office Furnishings and Equipment

It's easier today to make your office more attractive, more comfortable and a more efficient place in which to work, thanks to the wide range of smartly designed, functional furnishings made by progressive manufacturers like the Cramer Posture Chair Company, Inc., Kansas City, Missouri. More and more leading manufacturers are using Reynolds Aluminum in their products and here's why, in Cramer's case, according to J. A. Lang, Sales Manager.

Mr. Lang says, "We went into aluminum for our chairs to keep pace with the modern trend in the office equipment field. Aluminum offers eye appeal and light weight. We use aluminum in three forms . . . ingot, tube and sheet."

The Cramer Posture Chair Company manufactures a complete line of lightweight, precision aluminum constructed chairs in satin aluminum or baked enamel finishes. Aluminum is also used in their big line of metal stands, ladders, filing stools, utility stools, medical and hospital stools and other well-known products.

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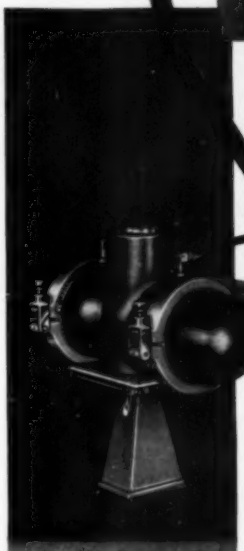

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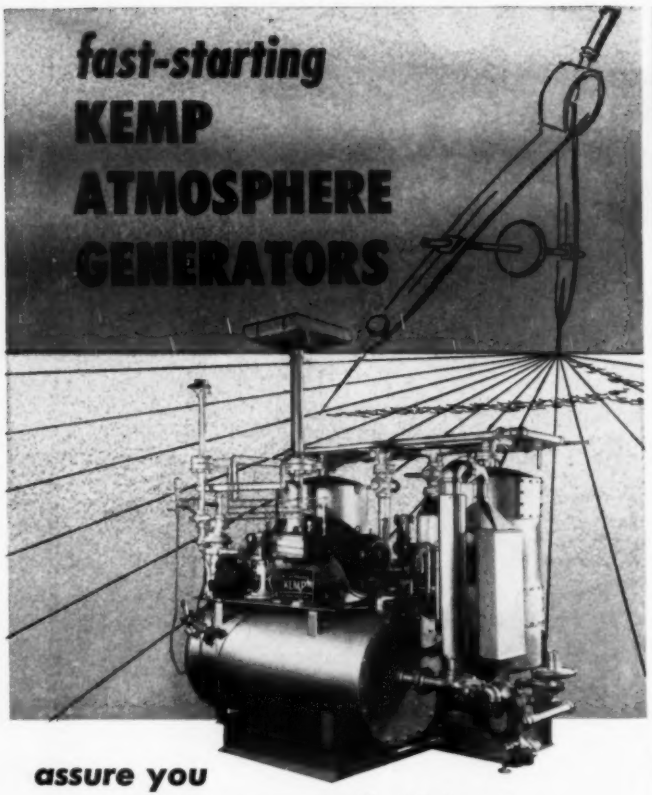

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Machinability Correlated With Inclusions*

THIS PAPER reports positive correlations between machining characteristics of bessemer steels, inclusion characteristics and silicon content. The results show that machining properties are governed by the number, size, shape and composition of the inclusions and that these characteristics are in turn dependent on silicon and oxygen content and subsequent mill practice.

A controlled heat of B1112, with silicon and oxygen additions, was used to reveal the correlations. The latitude of application of the correlations was then checked on samples of B1113 selected at random from 25 commercial heats. The so-called machinability index was that obtained on the familiar constant-pressure lathe. The inclusions were evaluated as to shape, size, and frequency by a statistical procedure using a microscope equipped with an ocular for grain size measurement.

It was found that large globular inclusions give the highest machinability index while the elongated (and, perhaps, more frequently "plastic") kind produce a substantially lower index. Inclusions were classified as "large" when they were at least 0.001 in. long, and "globular" when the ratio of length to width was within a range of 3 to 5. A length-to-width ratio of 3.5 produced a machinability rating of about 180 compared to a similar rating of 135 for a ratio of 13.4. Since sulphur was held constant at 0.20% in the controlled heat, the number of inclusions varied inversely with the size. Thus high machinability ratings were obtained with approximately 100 inclusions per sq.mm. and dropped substantially when the count increased beyond 200. The high count was accompanied by long stringy inclusions and higher silicon.

Through silicon additions, the content was varied from 0.007 to 0.044%. This was accompanied by corresponding length-to-width ratios from 3.2 to 13.4. The inclusion count varied similarly from 96 to 258. The dependency of both shape and size on silicon content seems firmly established.

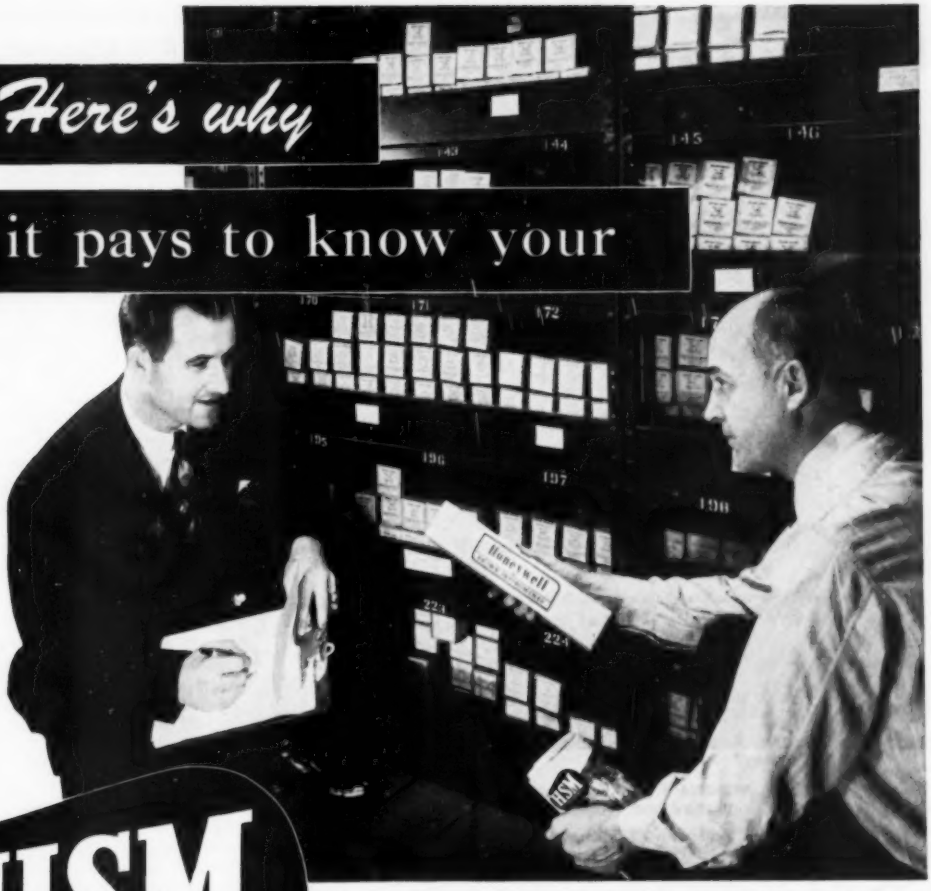
The Role of Oxygen — The bottoms of the ingots of the controlled

(Continued on p. 164)

*Abstract of "Correlation of Machinability With Inclusion Characteristics in Resulphurized Bessemer Steels", by Lawrence H. Van Vlack, © 1952 Preprint No. 16.

Here's why

it pays to know your



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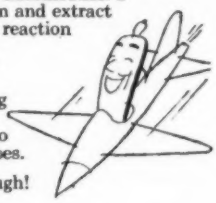
EMPLOYER: Amazing! But what do you do today?

AMMONIA: I grow farm crops, make ice, purify water, produce explosives.

EMPLOYER: I know you are a fertilizer, a refrigerant, and . . .

AMMONIA: Yes, and I serve as a protective atmosphere to surface-harden and anneal vital parts of planes and automobiles. I neutralize acid in petroleum and extract metals from ores. I'm a solvent and reaction medium in organic synthesis, a nutrient for yeast and a processing agent in the manufacture of alkalis, rayon, dyes, butadiene, and catalysts for cracking petroleum. I'm used in making vitamins, sulfa-drugs and radio and television parts and tubes.



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Machinability Correlated With Inclusions

(Continued from p. 162)

heat analyzed higher in oxygen due to segregation of MnO and SiO_2, thereby affecting the composition of the inclusions. This produced substantial reductions in the machining index and masked the correlations obtained with lower oxygen content. The mechanism of this effect was not investigated.

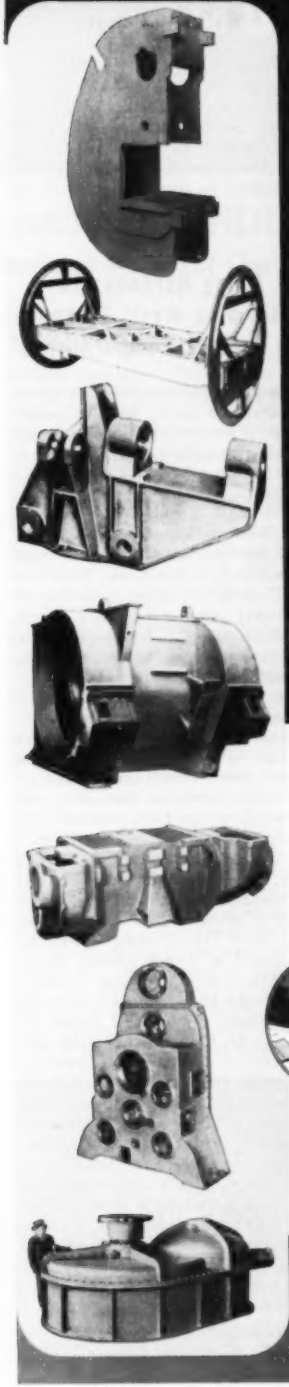
When the same techniques of analysis were applied to the 25 commercial heats of B1113, the same correlations were still evident as central tendencies but the dispersion was considerable, particularly in the lower silicon range where the large globular inclusions are to be expected. Furthermore, the dispersion did not appear to depend in any way upon the rather large range of oxygen content. There was, however, a significant correlation between the inclusion count and sulphur content; this confirmed the expected result from sulphur variations. The author of the paper suggests that fragmentation and plastic distortion of the inclusions resulting from commercial variations in mill practice could be expected to produce the dispersion apparent in the commercial heats.

It is evident that desirable machining properties arising from inclusions can be initiated by the proper chemistry but they may be destroyed by subsequent mill practice. In general, the machinability will increase with increased sulphur and with the sulphides in the form of larger globules.

Machinability Index — The machinability index as obtained by the constant-pressure lathe is unquestionably an influential factor in the machining performance of steel. Also, there can be no doubt about the correlation of this index with inclusion characteristics and related chemistry. *However, the reviewer would caution against a simple extension of these correlations to general practice in the machining of free-cutting steels.*

Most such steels are processed through automatic screw machines where thin-chip operations, such as reaming and form-turning, often dictate machining conditions. Tool life in these operations frequently is determined as much by surface finish as by tool wear, and both of these factors are quite sensitive to the directional properties assignable to

(Continued on p. 166)



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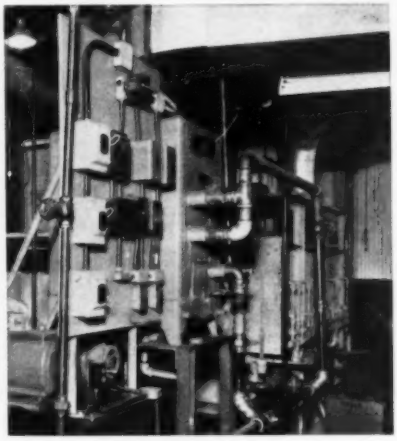

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Machinability Correlated With Inclusions

(Continued from p. 164)

cold drawing. It has not been established as yet that the desired properties for machining operations which feed radially to the stock are detected in a strictly cutting force test performed in the manner of an orthodox turning operation.

L. V. COLWELL

Using Hardness to Determine Metal Strength at Various Temperatures*

THE AUTHOR PRESENTS a very timely study of how, by the simple means of hardness testing, we should be able to gather a great deal of information concerning the strength of metals at various temperatures. By "strength of metals" it is assumed that Westbrook means substantially what Tiemann has defined as strength of materials in his book, "Iron and Steel", p. 330. A great many reports have been published on various correlations, such as hardness versus temperature, and hardness versus strength of metals. After a study of these reports, Westbrook proceeds to analyze the data to determine, if possible, a correlation between strength of metals and their various temperatures. For example, the relationship between hardness and temperature has been studied very extensively, as one can easily confirm by reading Chapter 7 of O'Neill's book, "The Hardness of Metals and Its Measurement". On the other hand, a graph such as that shown on p. 49 of "The Testing of Metallic Materials", by Ernest Skerry, shows that the Brinell hardness numbers are directly proportional to the tensile strength of the steel tested. If this is true, then we should be able to arrive at a relationship between the tensile strength of steel and the temperature at which it is measured, without going to the trouble of measuring directly the temperature dependence of the strength of materials. On p. 44 of the same book by Skerry, a procedure is given for the direct measurement of the relationship between tensile strength and temperature. Out of such studies have come some very important re-

(Continued on p. 168)

*Abstract of "Temperature Dependence of the Hardness of Pure Metals", by J. H. Westbrook, © 1952 Preprint No. 17.

Tool Steel Topics

BETHLEHEM STEEL

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CARBON TOOL STEEL—
Toolmakers' First Choice

So many tool steels have been developed for special applications that some people overlook the many uses for carbon tool steels. Actually they're used in larger quantities than any other type of tool steel. An experienced toolmaker usually considers them first, recognizing that they are the logical steels for a starting point.

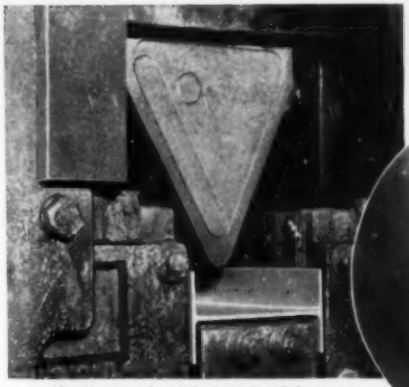
Here's why carbon tool steels are so popular:

- Easiest to machine of all tool steels
- Easy to heat-treat
- High surface hardness reinforced by a tough core
- They develop keen cutting edges

Hand chisels, center punches, and various shock tools are usually made from carbon tool steel having a carbon content of from 0.75 to 0.85 pct. Other ranges of carbon content: 0.90 to 1.00 for cold-heading dies; 1.00 to 1.10 for general-purpose tools and dies (this is the most frequently used analysis); and 1.15 to 1.25 carbon for stone-dressing tools, drawing dies, etc. Our carbon-vanadium steels, containing an addition of 0.15 to 0.25 pct vanadium, have similar applications in many instances.

The controlled hardenability and spheroidized structure of all Bethlehem carbon and carbon-vanadium grades assure uniform response in heat-treatment. Our extensive metallurgical research has established the ideal degree of hardenability for a wide range of applications. Your nearest Bethlehem distributor and our mill depot are at your service when you need top-quality carbon tool steel.

It's easy to machine this chamfering tool holder because all Bethlehem carbon tool steels are carefully spheroidize-annealed to provide a structure that's ideal for easy machining, easy heat-treatment.



After the triangular blade descends and shears a coupon from the web of the steel beam, it moves first to the left and then to the right to shear off the flanges. The lower knife is not visible.

The edge of this shear blade chipped because of misalignment which allowed it to strike the bottom blade. Heat-checking, caused by unexpected high temperatures, is also to blame for such failures.

When cold cuts make hot blades

The shear blades usually lasted about one week in a fabricating shop where steel beams and channels were cut in large quantities. Bad spalls on the cutting edges made it necessary to change blades about once a week, and it was taken for granted that little could be done to make them last longer.

One of our metallurgical men learned of this while in the shop on another job. He began to investigate and soon found that the "cold" cutting was generating about 700 F on the blades. This caused the tool steel to develop heat-checks. In addition, the blade was overloaded due to poor alignment which allowed it to strike the bottom blade. The combination of heat and overload explained the poor service life.

The solution: Hot-Work 8, one of our hot-work steels, was tried. It's an 8-pct molybdenum analysis that's tops in wear-resistance when operating temperatures are high. Tempered at 750 F, the first blade made a total of 45,000 cuts. The best previous record was 7,700 cuts.

Here's another instance of how the practical experience of our metallurgical contact men helps to put the finger on tool steel troubles.

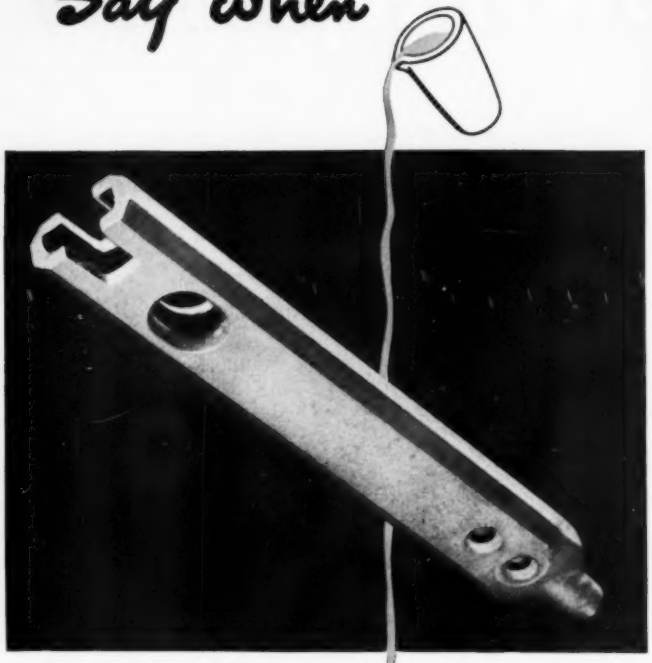
BETHLEHEM TOOL STEEL ENGINEER SAYS:
Heat-treat the tool, not the thermocouple

Improper temperatures during heat-treating frequently cause tool failures. In many instances the thermocouple chart shows proper heat-treatment temperatures, but the microstructure of the tool proves that the temperatures recorded were not attained by the tool. This is known as "heat-treating the thermocouple instead of the tool."

Most furnaces show some non-uniformity of temperature — locations near the source of heat are hotter than remote locations and the bottom tends to be colder than the top. A survey of each furnace will reveal the temperature differences which are present. This information makes it possible for the operator to select the location which will indicate most accurately the temperature of tools heated in the furnace; quite often the need for more than one thermocouple is apparent.

A thermocouple indicates the temperature of its tip only, so it's good practice to place the tip of the thermocouple as near to the tools as possible. Locations near the floor, sides, roof, or near the source of heat should be avoided. The thermocouple is an accurate and highly useful device, but it's not foolproof.

Say "when"



75¢ for this *Investment Casting*, compared to a former $2.17—same tool steel alloy, no machines or labor tied up producing it, and a more reliable product than before.

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when machining costs are "out of sight"

when the alloy is a tough one

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INVESTMENT CASTINGS

Using Hardness to Determine Metal Strength

(Continued from p. 166)

sults, and now that the parts of our modern jet engines are subjected to very high temperatures, the problem of ascertaining the effect of temperature on the mechanical properties of metals becomes a "must".

Westbrook, in this preliminary study of the literature on the correlations between mechanical properties of steel and corresponding temperatures, is reworking the "tailings of the old mine", and from it come many helpful suggestions as to how he should proceed in the study of effect of temperature on the mechanical behavior of metals. He believes there is sufficient evidence in literature to show that a simple hardness tester can be used in such a scientific study rather than using more complicated devices for studying the mechanical behavior of metals. In this the reviewer concurs, as well as with the contention that such a research is long overdue.

A little more than two years ago the reviewer had assembled equipment for a similar project, but was prevented by other problems from completing the experiment. The equipment, which needed only to have some "bugs" removed from it, would have provided a practical outfit for a dynamic method of hardness determination. Several hundred steel balls were ground to a size that they could be used in a .22 caliber rifle by removing the lead bullets from the cartridges and inserting the steel balls in their place. These were then to be fired at the surface of the specimen which was suspended with its furnace on a ballistic pendulum. Not only from the displacement of the pendulum, but from the sound track of the steel ball, the velocity of the ball (indenter) could be carefully checked, and knowing its mass, the energy producing the indentation could be determined. Thus the energy of impact E divided by depth D (related to the area A of impact) would give the hardness number; this could be found for metals at various temperatures.

The correlations which Westbrook has established are only approximate, but give him reason to attempt an experimental study which will confirm or invalidate the conclusions he has derived from this preliminary study of the reports of other investigations.

One very important observation

(Continued on p. 170)

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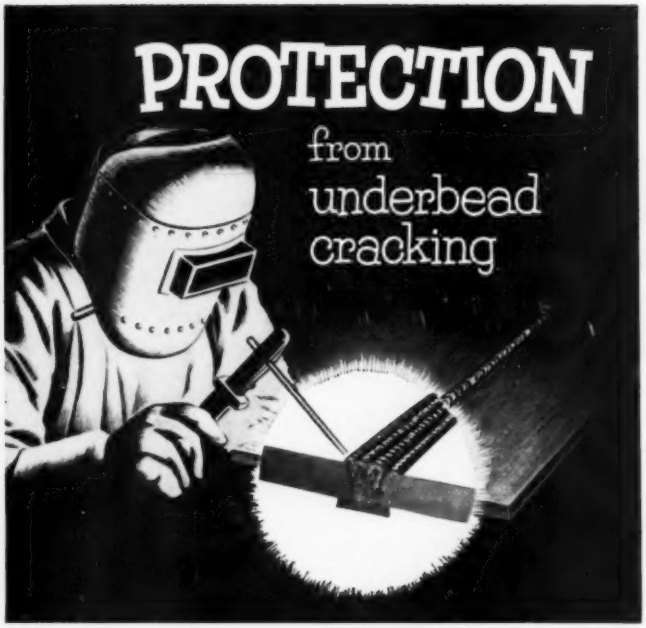

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Using Hardness to Determine Metal Strength

(Continued from p. 168)

which Westbrook makes is that, if possible, all future measurements should be carried out on single crystals. Only as we work with the individual crystal do we know what we have, and thus enable others to check our results.

I look forward with much interest to Westbrook's new experimental program. S. R. WILLIAMS

Nodular Iron at Elevated Temperatures*

SOME PROPERTIES of nodular iron were determined in the range of 800 to 1200° F. and compared with similar tests on a carbon and a molybdenum alloy steel.

This recently developed type of cast iron, which has some ductility and impact strength, is free of many of the limitations of conventional (flake graphite) cast irons and offers possibilities for many engineering applications in which cast iron has not been practicable. The test specimens of nodular iron were taken from a 3-in. section billet and tests were made of these in the as-cast and partially annealed conditions.

The proportional limits of both nodular irons at 800° F. were roughly 20,000 psi. higher than for the two steels. As the test temperature was increased to 1200° F., the proportional limits of the nodular irons decreased faster than of the steels but retained some superiority at 1200° F.

Comparisons of the 0.2% yield stress followed a similar pattern. The nodular irons were over 20,000 psi. higher at 800° F., and between the two steels at 1100 and 1200° F. The ultimate strengths of the nodular irons were slightly higher than for the steels at 800° F. but dropped to values between the two steels on the higher temperature tests. The faster decline in ultimate and yield strengths of nodular iron at the higher temperatures may be accounted for by some pearlite decomposition as temperatures approach 1200° F. (Such a structural change would not occur if a fully annealed ferritic iron were used.)

The ductility of the nodular iron as measured by percentage of elongation was much lower than for the

*Abstract of "Some Properties of a Nodular Iron at Elevated Temperatures", by M. S. Saunders and M. J. Sinnott, © 1952 Preprint No. 19.

steels. Ductility of the steels increased from roughly 30% at 750° F. to 55% at 1200° F., whereas that of the nodular irons increased from about 2% at 800° F. to 11% at 1200° F. The room-temperature ductility of these nodular irons was much lower than can be obtained with compositions more favorable to ductility.

Charpy impact tests were made on unnotched bars. As-cast nodular iron had an impact strength of 17 ft-lb. at room temperature and increased progressively to 40 ft-lb. at 1200° F. Periods of 100 and 1000 hr. at temperature produced no significant effect on the impact strength of the as-cast bars, but on the partially annealed specimens the longer periods of time improved the impact strength considerably.

Determinations of the load-carrying ability at 1200° F. were made by stress-rupture tests with constant loads for periods up to 10,000 hr. Both nodular structures followed very closely the values for the carbon steel but were lower than the alloy steel.

All the test values reported were admittedly applicable in detail only to the particular irons tested and not representative of the complete range of chemistry and heat treatment possible among the nodular irons.

From this work it seems safe to conclude that as a class of engineering materials, nodular irons compared to steels at elevated temperatures have lower ductility, equal or better ultimate tensile and yield strengths, lower impact strength but improved by high temperature, and stress-rupture strength at 1200° F. comparable to carbon steel.

S. F. CARTER

Effect of Boron in Carburizing Steels*

STEEL COMPOSITIONS corresponding to S.A.E. 4720, 8020, and 9420, with and without boron, and 9420 with boron and vanadium were investigated to determine the effect of boron on case hardenability after each of six hardening treatments following carburizing.

For each composition, four end-quench hardenability specimens were gas carburized for 16 hr. at 1700° F., air cooled to room temperature, and then reheated to 1475,

(Continued on p. 172)

*Abstract of "The Influence of Boron on Case Hardenability in Alloy Carburizing Steels", by C. F. Jatczak and E. S. Rowland, © 1952 Preprint No. 14.

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Effect of Boron in Carburizing Steels

(Continued from p. 171)

1525, 1600 or 1700° F. before end quenching; two additional specimens were pack carburized and either quenched directly from 1700° F. or furnace cooled in the carburizing container to 1525° F. and then end quenched. The carbon gradient in the carburized case after each of these six treatments was measured by chemical analysis of turnings from companion bars heat treated with the end-quench hardenability specimens. Hardness surveys of the case were made at selected carbon levels (ranging from 0.60 to 1.10%) and hardenability was expressed as the distance from the quenched end to a hardness of Rockwell C-60, this reportedly being the hardness of a structure containing approximately 90% martensite.

The results show that the hardenability effect of boron decreased with increase in carbon content of the case and became negligible above 1.00% carbon, regardless of the hardening treatment.

When reheated after carburizing, as in double-quench hardening practice, over-all hardenability increased in both the plain and the boron steels at all carbon levels as the quenching temperature was raised from 1475 to 1700° F. The hardenability effect of boron on the carburized case was negligible at the higher carbon levels and comparatively small at the lower carbon levels investigated when reheated to and quenched from 1475 or 1525° F. Thus, in double-quench practice, a hardening temperature higher than that normally used for steel without boron appears to be desirable when a boron steel is used. This is especially true if vanadium was not appreciably dissolved.

If quenched directly from the carburizing container, the hardenability effect of boron on the case was much greater than that which resulted from reheating and quenching from 1475 or 1525° F. For the 94B20 and 47B20-type steels, comparable results were obtained whether quenched directly from, or reheated to and then quenched from 1700° F.; in 80B20, however, the hardenability effect of boron was seemingly less when direct quenched. In this grade, as well as in the others, furnace cooling in the carburizing container to 1575° F. and then quenching yielded results

(Continued on p. 174)

How much heat from a "heat" of Chromel?

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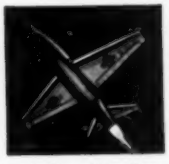

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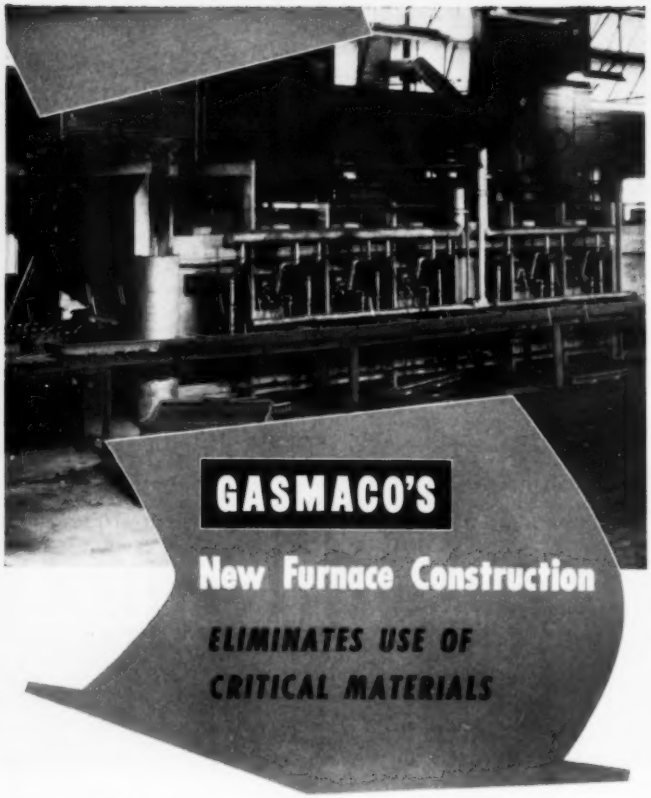

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Effect of Boron in Carburizing Steels

(Continued from p. 172)

comparable to those obtained on quenching directly from 1700° F.

The hardenability effect of boron was essentially the same in all three grades to which boron had been added as the same kind of ferro-alloy; this indicates that the effect of boron on case hardenability was independent of variation in the percentage of alloys among the 80B20, 94B20 and 47B20 types.

If the authors had chosen to measure hardenability on the basis of 90% martensite, determined by direct examination of microstructure rather than by the arbitrary Rockwell C-60 criterion, the hardenability factors reported for boron would probably have been somewhat different. However, the same trends relative to the effect of heat treatment and composition would very likely have been observed. As applied to commercial practice, the most significant conclusions with respect to the efficient use of carburizing steels containing boron are: *(a)* The carbon content of the case should be limited to about 0.90%; and *(b)* in double-quench hardening practice, the quenching temperature should be appreciably higher than the 1475 to 1525° F. range commonly used for steels containing 1.0% or more nickel; this applies especially to boron-vanadium steels. These results are in accord with commercial experience. For some applications, satisfactory results may be obtained without strict adherence to these limitations. P. R. WRAY

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TITANIUM METAL is won from TiO_2 in commercial production; however, the victory is never complete; currently about 0.05 to 0.15% oxygen by weight remains in solution in the metal. Next to nitrogen it is the most potent strengthener of titanium. Residual oxygen is therefore important and, in fact, oxygen is often deliberately added to titanium, both with and without metallic alloying elements, for strengthening purposes. Finally, normal hot working and annealing develop a complex oxide scale as well as an oxygen-enriched surface layer beneath the scale. Con-

(Continued on p. 176)

*Abstract of "The Titanium-Oxygen System", by E. S. Bumps, H. D. Kessler and M. Hansen, ⊕ 1952 Preprint 32.

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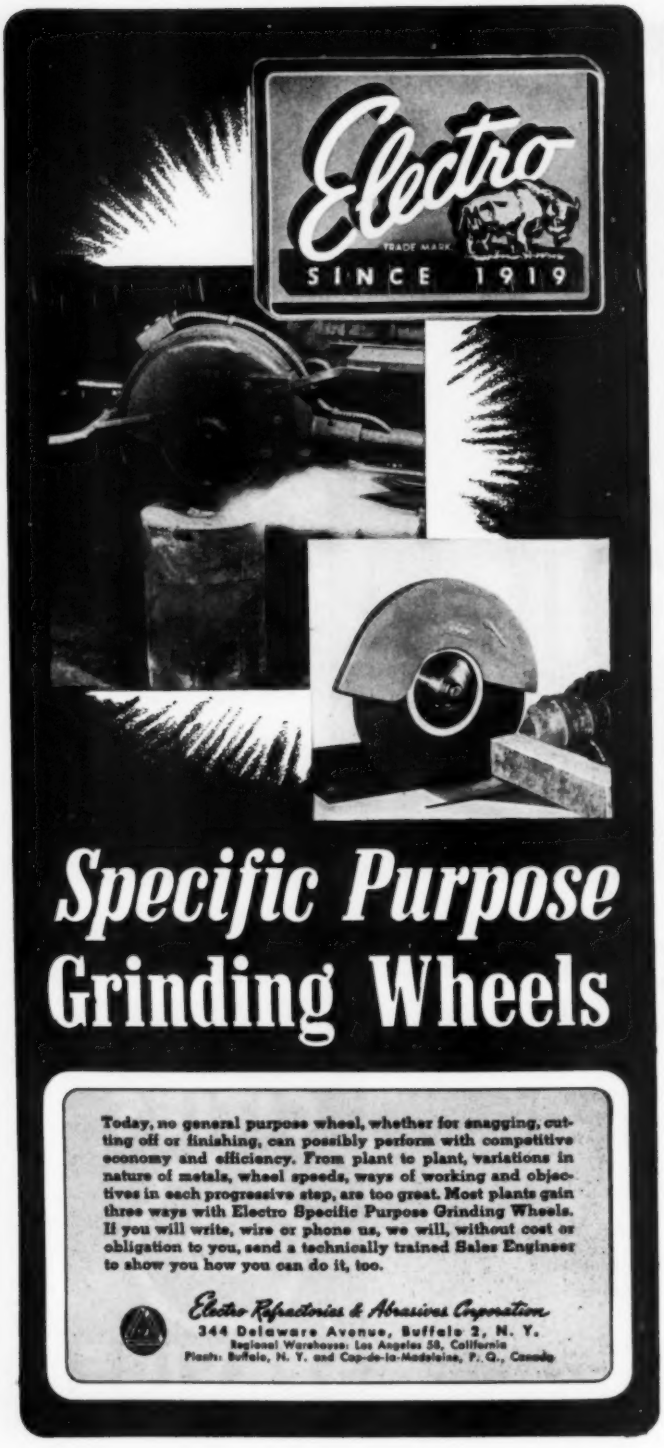
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Titanium-Oxygen System

(Continued from p. 174)

sequently, information on the titanium-oxygen system is of scientific and practical interest.

The titanium-rich portion of this system up through TiO has now been firmly established by Dr. Max Hansen's group at Armour Research Foundation, and it is understood that a group under Dr. Nielsen and Margolin at New York University has confirmed the Armour work in most essential details. The most interesting of these details to the titanium metallurgist are the large solubility of oxygen in alpha titanium (14.5% by weight above 1290° F.) and the quite steep rise of the alpha-beta transformation.

The large alpha solubility would appear to offer some assurance that oxide precipitation at room temperature, or somewhat above, would not occur with commercially pure titanium. However, this solubility was not investigated below 1290° F., so the possibility remains that low-temperature precipitation of oxide may occur in commercial titanium.

The sharp rise in transformation temperature accounts for the transformations that are higher by 36 to 72° F. in commercial titanium and titanium-base alloys—a factor to be considered in the heat treatment of oxygen-containing alloys.

The Vickers hardness was found to increase sharply over the alpha solid solution range from just over 100 for high purity titanium to just under 1000 at 13% oxygen (0.5% oxygen is perhaps the upper limit for alloys of commercial interest). The hardness dropped to about 400 at 15% oxygen, the start of the two-phase alpha plus TiO field. Increasing oxygen content then brought the hardness to over 1300 Vickers at 25% oxygen in the TiO field.

The major phase diagram features were found to be: A peritectic reaction, melt + $\alpha \rightleftarrows \beta$, between 1 and 5% oxygen at approximately 3165° F. A second peritectic reaction, melt + $\alpha \rightleftarrows$ TiO, between 14.5 and 20.5% oxygen at approximately 3220° F. A peritectoid reaction, α + TiO $\rightleftarrows \delta$ between 14.5 and 23.5% oxygen at approximately 1695° F. The alpha phase has a melting point near 3450° F. at about 10% oxygen.

The diagram was determined largely by micrographic analysis of arc-melted iodide titanium and TiO_2. X-ray diffraction was used to confirm solubilities and identify phases.

W. L. FINLAY

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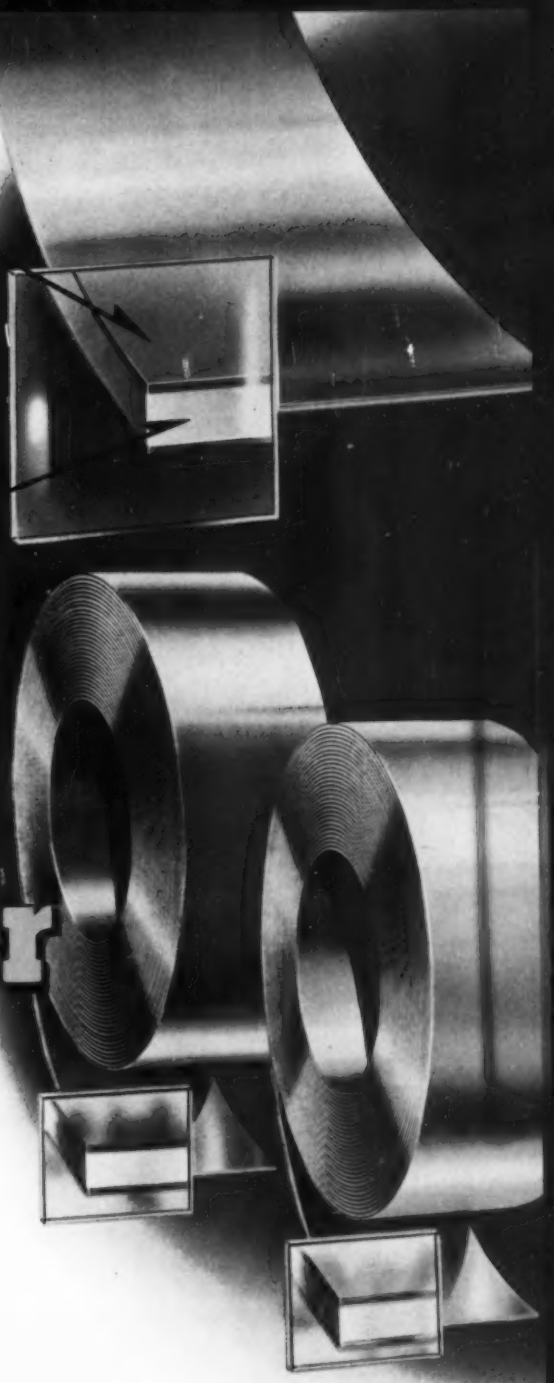

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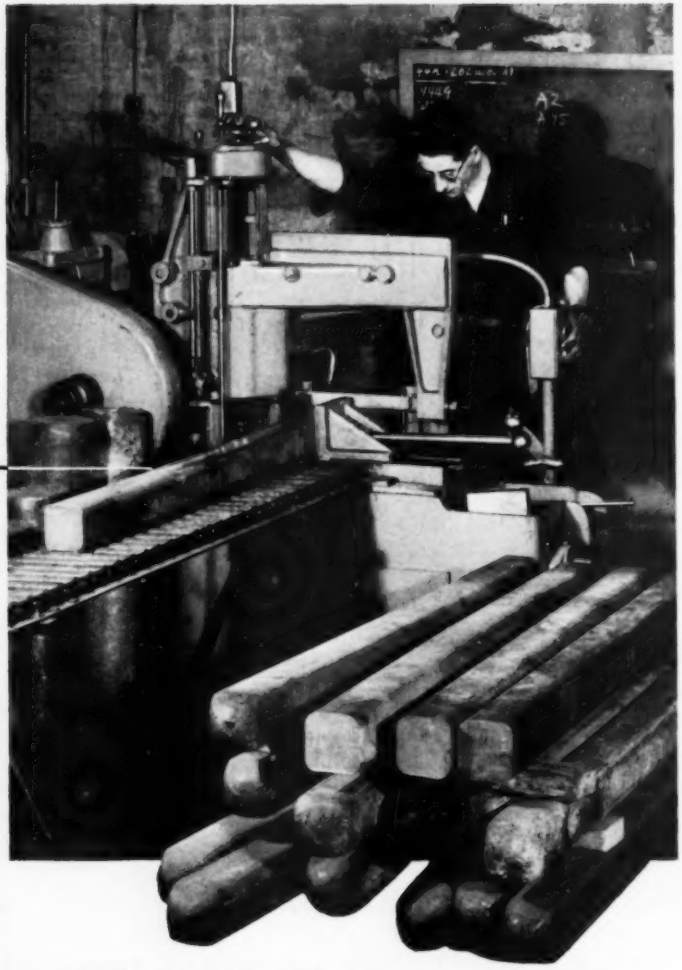

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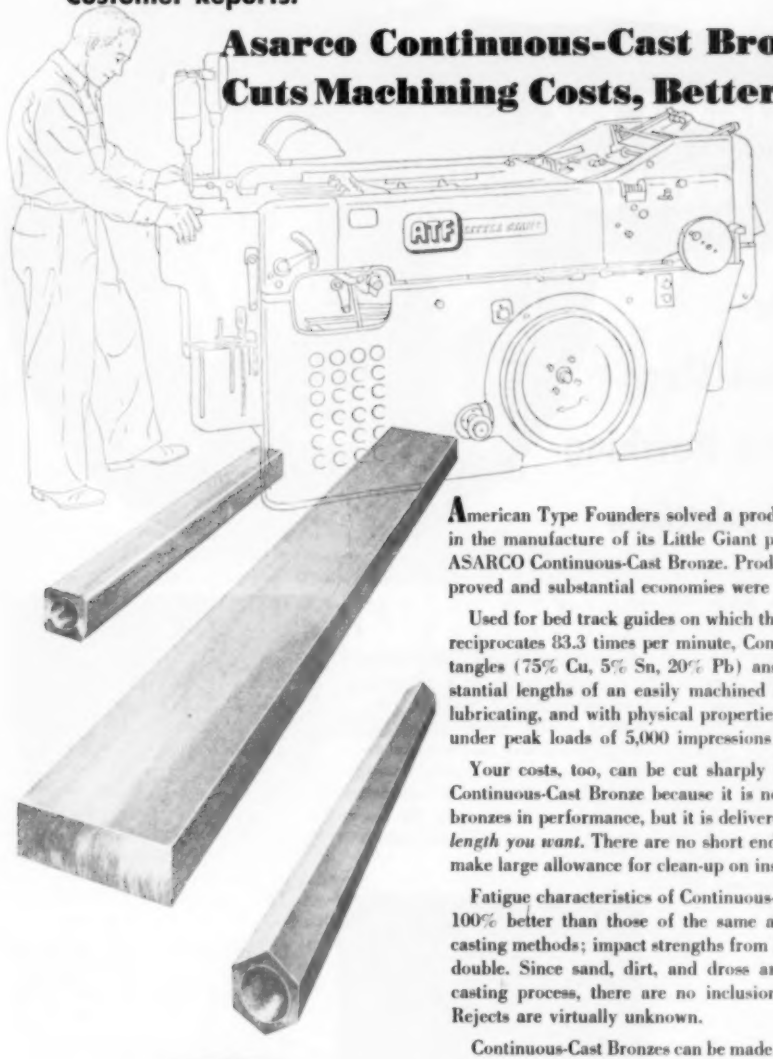

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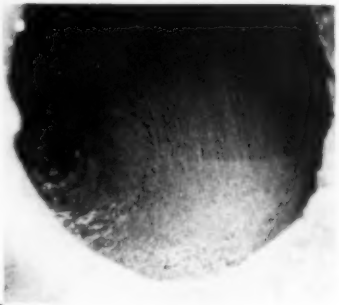
Tasil LININGS FOR ROTARY FURNACES

- **Last Longer**
- **Produce Less Slag**
- **Require Less Patching**
- **Increase Production**

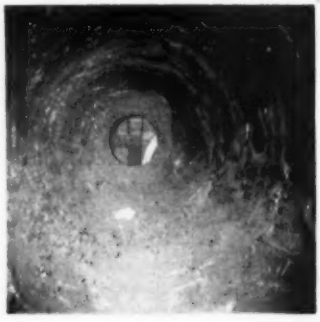
The following performance report is based on the experience of a large producer of centrifugal castings, operating rotary furnaces lined with Taylor Sillimanite (TASIL) super-refractories. This modern foundry manufactures bushings, rolls, pump rotors, etc., for textile and pulp and paper industries. Furnaces are also used for the recovery of scrap, chips and turnings, cast into ingots. (See photographs at right.)

•

If your foundry is melting similar alloys in rotary furnaces, it will pay you to investigate this proven TASIL application. For detailed information, call your nearest Taylor representative or write direct.



Photograph shows the TASIL brick and shape lining of a 2-ton rotary furnace *after three years* of intermittent service. Over 1,000,000 lbs. of monel and copper-nickel alloys were melted in this lining. There is no evidence of wear or joint erosion. The original 32" inside diameter has been maintained.



This photograph shows the condition of a *fireclay brick lining* after 15 months service in a 5-ton rotary furnace operated by the same manufacturer, in the same foundry, as furnace in photo above. Approx. 730,000 lbs. of low melting point alloys were melted. Service of this furnace was less severe, as very few copper-nickel heats were melted. Note extreme slagging. Lining has lost 2" to 3" in vulnerable areas.

Exclusive Agents in Canada:
REFRACTORIES ENGINEERING AND SUPPLIES, LTD.
Hamilton and Montreal

The CHAS. TAYLOR SONS Co.
A SUBSIDIARY OF NATIONAL LEAD COMPANY
REFRACTORIES SINCE 1864 • CINCINNATI • OHIO • U.S.A.

MILLER ELECTRIC

CUT MACHINING TIME FROM 2 HOURS to 1 HOUR and ELIMINATED WARPAGE

WITH GROUND AND POLISHED

STRESSPROOF®

SEVERELY COLD-WORKED, FURNACE-TREATED STEEL BARS

Arc Welder, made by Miller Electric Manufacturing Co., Appleton, Wis., uses STRESSPROOF in the generator shaft.

This 2¼" generator shaft, 19¼" long, must be drilled through its entire length, have both ends stepped down, and keyseated for 10¾". Ground accuracies are required for pressing on the armature. Drilling was a headache and the keyseating often resulted in severe warpage. It required two hours to finish one shaft.

Three different steels were tried before switching over to STRESSPROOF. When Ground and Polished STRESSPROOF was used, machining time was cut in half—one hour instead of two hours. Warpage was eliminated and the shaft itself was much stronger.

STRESSPROOF makes a better part at a lower cost.

STRESSPROOF has improved quality and lowered costs in hundreds of similar applications because of its unique combination of four qualities in-the-bar: (1) High Strength, double that of ordinary cold-finished shafting; (2) Machinability, fully 50% better than heat-treated alloys of the same strength; (3) Wearability, without case hardening; and (4) Minimum Warpage. STRESSPROOF is available in cold-drawn or ground and polished finish.

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Free Engineering Bulletin
"New Economies in the Use of Steel Bars"

La Salle **STEEL CO.**

. . . the Most Complete Line of Carbon and Alloy Cold-Finished and Ground and Polished Bars in America.

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Hammond, Indiana

Please send me your STRESSPROOF Bulletin.

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Title _____

Company _____

Address _____

City _____ Zone ____ State _____

A Program for 30 million new Americans

LISTEN to the voices of 30 million new Americans. They are answering the pessimists who say we are threatened with depression because we can't keep our farms and factories busy.

Let these pessimists read the future in the census returns. There is a tremendous upsurge in our population. Last year nearly 4 million babies were born. By 1960 we shall total 170 million people--30 million more than when war ended in 1945. This adds to our domestic market more people than there are in Canada and Australia combined.

Providing for these 30 million new Americans can keep our production machinery going at capacity. They call for new hospitals, schools and churches. Larger families need bigger houses to replace post-war houses that are too small now. More and bigger families need improved home equipment and more new automobiles. In short, to maintain and improve living standards for our children, we must work harder than ever before. To supply the needs of our 1960 population, including adequate national defense, it is estimated that the productivity of the individual worker must increase at least 30%, with additional investment of over 200 billion dollars in capital facilities.

There should be no room in this picture for depression. But we must have economy in government, elimination of waste and extravagance and a reduction of taxes and public debt. If we encourage private incentive, thrift and investment, we can bring about the greatest advance in health, wealth and happiness that America has ever known.

QUALITY YOUNGSTOWN SERVICE

The Youngstown Sheet and Tube Company

General Offices--Youngstown 1, Ohio

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MANUFACTURERS OF CARBON ALLOY AND YOLOY STEELS

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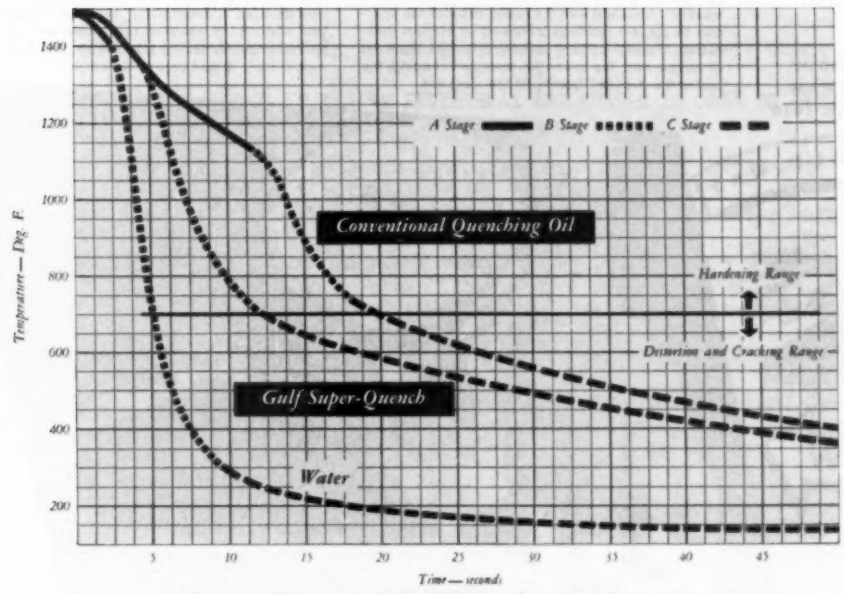
For deeper, more uniform hardness on steels of critical hardenability—

GULF SUPER-QUENCH



Center cooling curves, 18-8 stainless steel specimen ½ in. diameter x 2½ in. long, quenched from 1500°F.; oil temperature 120°F.

Is the current alloy shortage creating a heat-treating problem for you? Must you accept alloy steels with less nickel, molybdenum, and chromium than you specify or hope to obtain?

Perhaps your problem can be solved through the use of Gulf Super-Quench. Because of its greater quenching power, this superior quenching oil helps offset the lower hardenability of today's substitute steels.

As shown above, Gulf Super-Quench passes through the vapor transport stage far more quickly than conventional quenching oils. This means that the cooling rate is extremely fast at the outset, an important factor in the depth and uniformity of hardening. In the succeeding stages Gulf Super-Quench has a slow cooling rate, like that of conventional quenching oils, and therefore has the same minimum tendency toward distortion and cracking.

Greater quenching power of Gulf Super-Quench adds up to greater depth of hardening and more uniform hardness! One of the most practical advantages of Gulf Super-Quench is greater uniformity of results on steels of variable hardenability.

For further information on Gulf Super-Quench, call in a Gulf Sales Engineer today. Write, wire, or phone your nearest Gulf office.

Gulf Oil Corporation · Gulf Refining Company
Pittsburgh 30, Pennsylvania

GULF SERVES INDUSTRY

New- NOTHING ELSE LIKE IT

FLEX-TESTER

For non-destructive testing of sheet metal for drawing qualities and stretcher strain

Developed by Jones and Laughlin Steel Corporation and manufactured and sold exclusively by Steel City Testing Machines, Inc.

This important contribution to sheet metal testing is simple, compact and does its job quickly. The **Flex-Tester** bends a corner of a sheet through a standard arc measuring on a dial indicator the resistance of the metal to the bending operation. A **"Dial Converter"** furnished with the tester enables the operator to convert readings obtained on various thicknesses of material to a standard for the purposes of comparison. The lower the corrected reading, the better the drawing quality of the material.

A **spherometer** is also supplied. It measures the curvature of the permanent set of the metal and thereby gives an indication of the stretcher strain characteristics. The **Flex-Tester** is a must for steel mills, stamping plants, warehouses. Write us if you wish detailed information on the **Flex-Tester** or if you wish us to have a representative call and demonstrate this testing machine to you. It is lightweight (only 6 lbs.) and easily carried.

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Metal Show
Booth No. 1416

FLEX-TESTER TESTS FOR DRAWING QUALITY

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ALLOY PRECISION Castings Company

EAST 45th ST. AND HAMILTON AVE. • CLEVELAND 14, OHIO

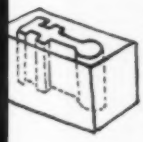
Important
pass this on

To Executives Charged with Responsibilities
of Design, Development and Production:

This is intended to call your attention to the Mercast frozen mercury process of investment casting — a development that manufacturers find helpful in solving difficult design and production problems. We suggest that you immediately investigate this versatile process which makes available one-piece shapes previously impossible to cast or machine.

Get this!

Frozen mercury patterns and our special ceramic investment material permit surface finishes and dimensional tolerances never before available in foundry production. For example, ±.002 to .003" per inch is consistently held. In many applications, our castings require no finish machining. Some mercastings, with intricate shapes and cavities, were previously fabricated parts which required expensive machining and assembly, or were too costly to make at all.



Big savings here... up to 78%?

PLASTIC MOLD CAVITY BLOCKS?

Our metallurgists can help you get mass production in such hard-to-machine metals as pure nickel, Hastalloy B, Rexalloy 108, stainless, Stellite, and others, both ferrous and nonferrous, at exceptionally close tolerances. Current applications — radar, aircraft, automotive, electrical, and machinery — indicate the wide, economical adaptability of mercasting. Here may be the answer to your problems involving design ... materials ... costs ... weight ... time ... machining capacity.

this hits home

If this discussion suggests use of mercastings by your company, write to Dept. A-7 for Bulletin 706 — or tell us your specific problems. Our metallurgists and Mercast engineers will be glad to serve you.

Drop a note today!
Send those tough problems...

Sincerely,
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Alloy Precision Castings Company

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BRASS CASTINGS FILL THE SPECIAL REQUIREMENTS OF MANY MANUFACTURERS

The free cutting characteristics of Brass are ideal in the manufacturing of all types of valves, impellors, plumbing fittings and other castings that require machining. This adjunctive feature provides for lower tool maintenance costs . . . more rapid machining, which in effect leads to increased production.

FREE . . . Write for your copy of the 8-page Lavingot Technical Journal — Vol. 8, No. 3 — containing an article discussing "Gates and Risers."

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AMERICAN CHEMICAL PAINT COMPANY

AMBLER CHEMICALS ACP PROCESSES PENNA.

Technical Service Data Sheet

Subject: IMPROVING PAINT ADHESION ON STEEL WITH GRANODINE®

INTRODUCTION

"Granodine" is a zinc phosphate coating chemical which improves paint adhesion on steel, iron and zinc surfaces. In the Granodizing process, a non-metallic crystalline coating is formed on the treated metal. This bond holds and protects the paint finish and thus preserves the metal underneath.

"GRANODINE" MEETS SERVICE SPECIFICATIONS

The protective "Granodine" finish meets the requirements of:

JAN-C-490, Grade I	CLEANING AND PREPARATION OF FERROUS METAL SURFACES FOR ORGANIC PROTECTIVE COATINGS
JAN-F-495	FINISHES, FOR EQUIPMENT HARDWARE
U.S.A. 57-0-2C Type II, Class C	FINISHES, PROTECTIVE, FOR IRON AND STEEL PARTS
U.S.A. 51-70-1, Finish 22.02, Class C	PAINTING AND FINISHING OF FIRE CONTROL INSTRUMENTS; GENERAL SPECIFICATION FOR
MIL-V-3329	VEHICLES, COMBAT, SELF-PROPELLED AND TOWED; GENERAL REQUIREMENTS FOR

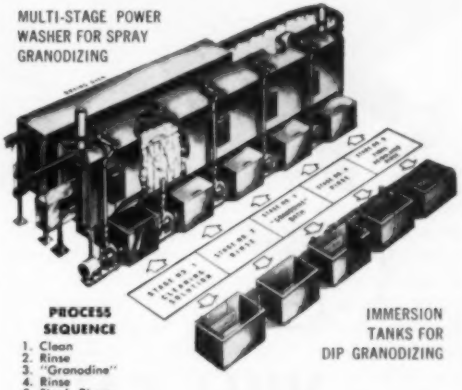
Official Dept. of Defense Photograph

An F4U Corsair with the Navy's new aircraft anti-tank rocket, the "RAM". A Grade I zinc phosphate finish (JAN-C-490) protects the entire external surface of this rocket and provides a durable bond for the specification paint finish.

GRANODIZING DATA

Granodizing is an easily applied chemical process. Depending on the size, nature and volume of production, Granodizing can be carried out by spraying the parts in successive stages of a power washing machine, by dipping the work in the cleaning, rinsing and coating baths contained in tanks, or by brushing or flow coating the work with portable hand equipment. Typical process sequence and equipment requirements are shown below:

MULTI-STAGE POWER WASHER FOR SPRAY GRANODIZING



PROCESS SEQUENCE

1. Clean
2. Rinse
3. "Granodine"
4. Rinse
5. Final Rinse

IMMERSION TANKS FOR DIP GRANODIZING

NOTE: Equipment can be of mild steel throughout, except in the Granodizing stage, where nozzles, risers, and pump impeller should be of acid-resistant material.

MANY APPLICATIONS

Automobile bodies and sheet metal parts, refrigerators, washing machines, cabinets, etc.; projectiles, rockets, bombs, tanks, trucks, jeeps, containers for small arms, cartridge tanks, 5-gallon gasoline containers, vehicular sheet metal, steel drums and, in general, products constructed of cold-rolled steel in large and continuous production are typical of the many products whose paint finish is protected by "Granodine".

CHEMICALS ACP PROCESSES

WRITE FOR FURTHER INFORMATION ON "GRANODINE" AND YOUR OWN METAL PROTECTION PROBLEMS.

CHEMICALS ACP PROCESSES

In these days of

HIGH DIE COSTS

MicroRold® Stainless Steel Sheets

WILL SAVE YOU MONEY!

The unusual uniformity of gauge in MicroRold allows for closer die setting, assuring the fabricator of uninterrupted production in stamping, forming and blanking operations.

This closer control of MicroRold sheet thickness ***increases the productive life of the die and reduces to an amazing degree the number of rejects.*** One fabricator reports less than ½ of 1% breakage in a 12½" draw on a 17" blank with a rectangular cross-section.

From edge to edge—and end to end—only MicroRold has such outstanding uniformity of gauge.

WASHINGTON STEEL CORPORATION

WASHINGTON, PENNSYLVANIA

forging or extruding?

then HERE'S A MESSAGE FOR YOU

Yes, if you're considering forging or extruding, this message is directed to you. Whether it be aluminum, magnesium, copper, brass or steel, Magnethermic has a 60-cycle induction ingot heater to fit your needs. Be it a 400-pound or a 15,000-pound-per-hour unit, there is a standard heater to fit your needs and do a better heating job for you. Here's why.

Magnethermic has specialized in ingot heaters since its formation. Not only have we developed a wide range of sizes and types of heaters, but we've developed a unit that solves many of the heating problems that have faced industry for years. Most of the extrusion presses installed in the past three years have been equippd with Magnethermic heaters for heating the ingot. The solution to these problems has resulted in universal acceptance of this equipment by the extrusion industry and enabled us to develop standard heaters and pass the resultant savings on to you.

The Magnethermic Induction Heater is a compact, neat unit. It is shipped to you completely assembled, ready for operation. It is a highly flexible, automatic unit—requiring no warm-up time, no specialized skill for operation and takes a bare minimum of floor space. Its many advantages include: accurately controlled billet temperature; tapered heat control; cool operation resulting in optimum working conditions to personnel; instantaneous response, eliminating warm-up time and many other features. Yes, it's priced competitively, too.

Write today for our new informative bulletin.

60-CYCLE

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corporation

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EUROPE: Loewy Engineering Co., Ltd., Bournemouth, England

INDUCTION HEATING

Your inquiry —

We have specialized in the heating of metals for hot working and are qualified to give you some real help. Write or phone today for prompt attention to your needs.

MICROCAST PRECISION CASTINGS PROCESS
microcast®
design flexibility
Many small, intricately shaped parts that are now being fabricated separately by conventional methods can be economically Microcast into one stronger, ready-to-assemble component. Combining up to three small parts into one solid casting eliminates many costly machining and assembly operations and allows the engineer to design simpler components with a greater strength factor.
Design for fewer machine operations—design for better parts at less cost—design for longer part life and for functional improvements from the use of better metals and alloys... design with Microcast in mind!
Write for New Microcast Book
MICROCAST DIVISION
AUSTENAL LABORATORIES, INC.
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715 East 69th Place, Chicago 37, Illinois

High-Speed End Heating of Sucker Rods

(Continued from p. 117)

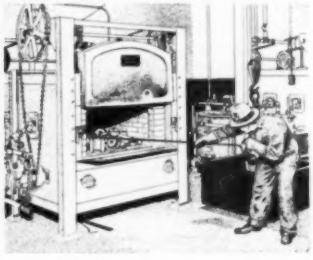
of this width, stock could not be moved directly from the storage racks in the back of each furnace without an additional transfer. Now, due to the narrower width of the high-speed units, larger rack loads can be moved by transfer car directly from storage rack to furnace conveyer. This results in a considerable saving in time and manpower, which of course is important in mass production on a piecework basis.

Operator comfort is also good. "Sting-out" from the hearth is prevented by an air curtain. Heated stock is automatically delivered close to the upsetter. Tiring movements are thus minimized. During the shutdowns common to any forge shop, the operator merely withdraws the bars from under the burners and replaces them on the transfer car until operation resumes. No helper is required to handle the rear end of the sucker rod while the hot end is moved from furnace to upsetter to rack — a skid rail is sufficient.

The existing building and upsetters determined the arrangement of heaters at the Toledo plant — four furnaces arranged in a row. Some handling and turning of rods, end to end, could be avoided in a newly designed plant by having furnaces and upsetters in pairs, one at one end of the rod racks, one at the other end.

CONCLUSION

Continued operation of four "Surface" high-speed gas-fired forge furnaces has resulted in increased production of sucker rods with better machining and forging properties than previously obtained from conventional slot forge furnaces. Comfort, which can be a problem in any forge shop, has improved, and overall production costs due to rejects and die maintenance have been notably reduced. Savings in time, space and fuel are also considerable.



a few words about alloy steels

or...THE ALTERNATE ALLOY that never interrupted production

This could happen to you! A customer of ours was forced by restrictions and alloy shortages to switch from the Republic alloy steel he'd been using for years to one of the alternate alloys that he could get. He'd dreaded the problems of redesigning tools and dies, of revising heat-treating procedures, of heavy reject rates while the switch was being made.

But these troubles never came!

He called upon the Republic 3-Dimension Metallurgical Service . . . the Republic Field Metallurgist, backed up by the Republic Mill and Laboratory Metallurgists. These three men worked with the customer's metallurgist and his production foreman. Together, they analyzed his requirements, recommended the best available alternate steel, worked out the way to form the steel and heat-treat it.

The shift was made with almost no interruption, and never a headache.

We may be able to do the same job for you . . . and to back up our recommendation with one of the many fine alloys produced by Republic . . . world's largest producer of alloy and stainless steels.

REPUBLIC STEEL CORPORATION
Alloy Steel Division • Massillon, Ohio
GENERAL OFFICES • CLEVELAND 1, OHIO
Export Department: Chrysler Building, New York 17, N. Y.

Other Republic Products include Carbon and Stainless Steels—Sheets, Strip, Plates, Pipe, Bars, Wire, Pig Iron, Bolts and Nuts, Tubing

CONTINENTAL

For the OVER-ALL JOB—With Guaranteed Results in

FURNACES • OVENS • DRYERS

...ge, Continental Rotary Hearth Billet Heater. Automatic charging and discharging manipulators control delivery of uniformly heated billets to extrusion press.

PRODUCTION UNITS
BUILT FOR

Nitriding
Cyaniding
Sintering
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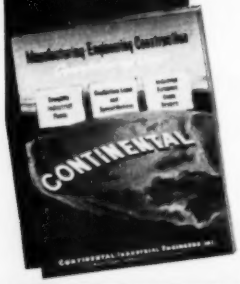
Annealing
Hardening
Melting
Brazing
Drawing
Billet Heating
Metal Coating
Malleablizing
Ore Smelting
Salt Baths
Soaking Pits
Forging
Core Baking
Mold Baking
Drying

Electric or Fuel Fired



for military production . . .

Whatever your heat process problems in plant conversion for military production, CONTINENTAL has the answer.

CONTINENTAL jobs begin with analysis of the requirements, then the selection and development of proper methods for greatest results. Finally follows the design, the building, and installation of the equipment including necessary work-handling accessories and control devices—delivering a COMPLETE UNITIZED PRODUCING PACKAGE with results guaranteed.

The broad experience of CONTINENTAL offers you a prompt, sure solution to your change-over program.

CONTINENTAL INDUSTRIAL ENGINEERS, INC.
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PLANNED MILITARY PRODUCTION
Write for Booklet No. 127

FURNACES
PRODUCTION LINES
CONTINENTAL
SPECIAL MACHINES
COMPLETE PLANTS

MANUFACTURERS—ENGINEERS—CONTRACTORS FOR OVER A QUARTER OF A CENTURY

New Melt Shop for Forge Plant

(Continued from p. 120)

ulator, centrifugal filter, bag-type filter and suitable connection for wiring and air hose) is an integral part of the installation.

This pyrometer is subjected to rather severe treatment in service, so its calibration is checked frequently. A standard checking unit with a system of signal lights, and an adjusting dial on the control panel of the tube, permit a quick setting to bring the indications in line with the standard.

Complete facilities are installed for rapid checks on chemical and physical properties of heats in process. Of considerable assistance in this work is a Baird direct-reading spectrometer which, in a matter of seconds, supplies a full record of alloy content of any given sample. Specimens are taken from the furnace by means of evacuated glass tubes, providing ¼-in. pins which can be quickly ground to shape on the end for sparking in the spectrometer. Twelve dials record the percentages of the various elements, adjustable for different elements or for different degrees of sensitivity at various lines in the spectrum.

Carbon and sulphur checks are made by conventional combustion techniques, and phosphorus by chemical analysis. Possibly the spectrometer can be perfected for a quick determination of phosphorus. Telephone and telautograph connections between laboratory and melting floor expedite the transmittal of analytical data.

Metallurgical control at Finkl plants extends some distance beyond the melting and ingot-making phases.

As a final metallurgical control procedure, blocks are tested with the ultrasonic reflectoscope, which gives a nondestructive indication of any significant internal defects.

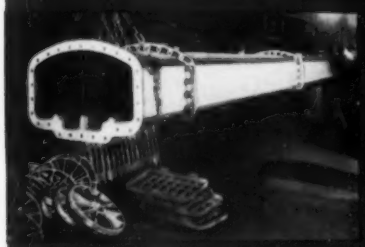
SUMMARY

While this new electric steel plant has been operating for such a short time that the economics of the scheme have yet to be completely settled, the very decision to build such an expensive adjunct to a forge plant seems to support that rising body of engineering opinion which holds that individual users of considerable quantities of steel can profitably make their own in small,

(Continued on p. 198)

Retort weighing 2,000 pounds is machined in a D-H machine shop. Retorts up to 5,000 pounds can be handled here.

D-H
FURNACE PARTS AND FIXTURES mean LOWER HEAT-HOUR COSTS



Muffle weighing 6,500 lbs. being assembled in a D-H foundry. One section Nichrome, remainder Chromax. (Note trays and other fixtures nearby.)

Spectrograph equipment at Driver-Harris supplies one of the most efficient means for precise metallurgical control.

Low heat-hour costs are "manufactured" in the form of durable equipment that can deliver peak performance economically throughout a long life of trouble free operation.

To manufacture low-heat hour costs requires exceptional facilities: A reservoir of accumulated heat-treating experience, a profound knowledge of metallurgy, a corps of expert technicians, and ready availability of all necessary means for producing furnace parts and fixtures—so that checks and controls can be easily and efficiently applied at all stages of manufacture.

At Driver-Harris, we have all of these. We have amassed over 40 years of practical foundry experience. We have developed, with exclusive techniques, the highest-grade nickel-chromium alloys—such as Nichrome* and Chromax*—that give top-level performance and stay on the job despite high heat, punishing cycles and fast quenching. Our engineering and designing divisions, furnaces, pattern shops, foundries, rolling mills, welding and machine shops provide all the facilities for manufacturing furnace parts and fixtures of all types, utilizing castings, sheet, bars, wire, or wire mesh.

Size is no object. Whether it be baskets weighing a few pounds each, or retorts weighing several thousand pounds apiece, we are equipped to supply units "tailored for the job."

Under present conditions, strategic metals and the alloys made from them are inevitably on strict allocation. However, we shall be glad to make recommendations based on your specific needs, and serve you to the best of our ability.

*T.M. Reg. U. S. Pat. Off.

Driver-Harris Company

HARRISON, NEW JERSEY

BRANCHES: Chicago, Detroit, Cleveland, Los Angeles, San Francisco

MAKERS OF WORLD-FAMOUS NICHROME AND OVER 80 ALLOYS FOR THE ELECTRICAL, ELECTRONIC AND HEAT-TREATING FIELDS

IT'S THE FINISH THAT COUNTS

Roto-Finish COMPOUNDS AND CHIPS ARE MADE TO GIVE YOU THE PROPER FINISH ECONOMICALLY

There are other brands of materials that resemble Roto-Finish chips and compounds . . . but only Roto-Finish chips and compounds give you the *extra advantage* of continuous research by the company who originated the Roto-Finish processes. Roto-Finish chips and compounds are carefully manufactured so *you* obtain the best results on *your specific job*. To obtain the best results at the lowest cost . . . insist on ROTO-FINISH chips and compounds.

SAVES MAN HOURS AND MONEY by eliminating hand finishing.
GIVES ABSOLUTE UNIFORMITY...in any quantity.
MAINTAINS PRECISION TOLERANCES.
CUTS FINISHING costs as much as 80%.
LOWERS INITIAL and MAINTENANCE costs.

Roto-Finish COMPANY
associated with The Sturgis Products Co.
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P. O. Box 988—
Phone 3-5578

See the Roto-Finish Machines on display at Booth No. 244 by our distributor, F. B. STEVENS, INC., National Metal Exposition, Philadelphia Convention Halls, October 20-24, 1952.

New Melt Shop for Forge Plant

(Continued from p. 196)

independent units, and successfully compete with the product from large, integrated steel companies. The Finkl plant can easily turn out 4500 tons of ingots a month, working two furnaces around the clock. This is probably somewhat in excess of in-plant requirements for carbon and alloy steel, leaving a small tonnage available for outside sale in the Chicago area.

One favorable influence which doubtless has much to do with the balance sheet is that no rolling mill is necessary — all ingots are cogged direct. Furthermore, a convenient and ample supply of good scrap, plus plenty of electric power at reasonable rates from Commonwealth Edison Co., are key factors pointing to the possibility of an attractive performance, cost-wise.

High-Temperature Properties of Monel*

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At 700° F., an increase in grain size produced higher creep strength and shorter rupture life. At higher temperatures, an optimum grain size of 0.1 to 0.2 mm. gave maximum rupture life. The authors state there may or may not be an optimum grain size for the lowest minimum creep rate, depending on the temperature and stress. There is an optimum grain size at 900 and 1100° F., but at 1300° F. the minimum creep rate decreases with increasing grain size.

The influence of grain size on total elongation and reduction of area was small below the equicohesive temperature and increased with decreasing grain size above the equicohesive temperature. Reduction of area was higher than elongation at lower temperatures and lower than elongation at higher temperatures.

W. A. MUDGE

*Abstract of "Influence of Grain Size on High-Temperature Properties of Monel", by Paul Shahinian and J. R. Lane, © 1952 Preprint No. 6.

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Surface Stress in Hard Steel*

THEORETICALLY it should be possible to measure the strain imposed in a metallic crystal by a known load by measuring the lattice parameters before and after loading. Despite much effort, the procedure has never given satisfaction — especially for hard steel — because the small differences in crystal lattices could not be measured accurately enough. Many of the difficulties arise from the fact that lines refracted from hardened steel, when X-radiation from the usual cobalt or iron targets are used, are wide with no well-developed peaks and stand up only a little above the self-induced background radiation. The present authors avoid this by filtering out this background radiation by 0.001-in. vanadium foil, and using long wavelength X-rays from chromium. This is a "soft" radiation and does not penetrate very far into the sample under study; the reflections therefore come from surface layers on the specimen.

The authors discuss the requirements for accurate work, such as placement of specimen in the back-reflection spectro-goniometer, use of an auxiliary slit to narrow the cone of reflected beams, and technique for locating the actual peak of a somewhat blunt line. Two sets of observations are made, one where the axes of incident and diffracted beam make equal angles with the surface, and the other after the specimen has been rotated 60°. From the relative positions of a strong reflection from a given set of parallel crystallographic planes the interplanar distance may be computed. If these are then compared with the same dimension for unstressed metal (as in powdered material) the average internal stress may be computed. Or a series of tests may be made on metal under known external loads.

To indicate the accuracy obtainable the authors cite measurements on tubes, 4 in. outside diameter, ½ in. wall, made of carburized 4620 hardened to C-60 plus. In one series of tests the surface was electrolytically etched. Comparing the X-ray data from this tube, free of external stress, with that from powdered metal of the same composition

(Continued on p. 202)

*Abstract of "X-Ray Measurement of Residual Stresses in Hardened High-Carbon Steel", by A. L. Christenson and E. S. Rowland, 1952 Preprint No. 22.

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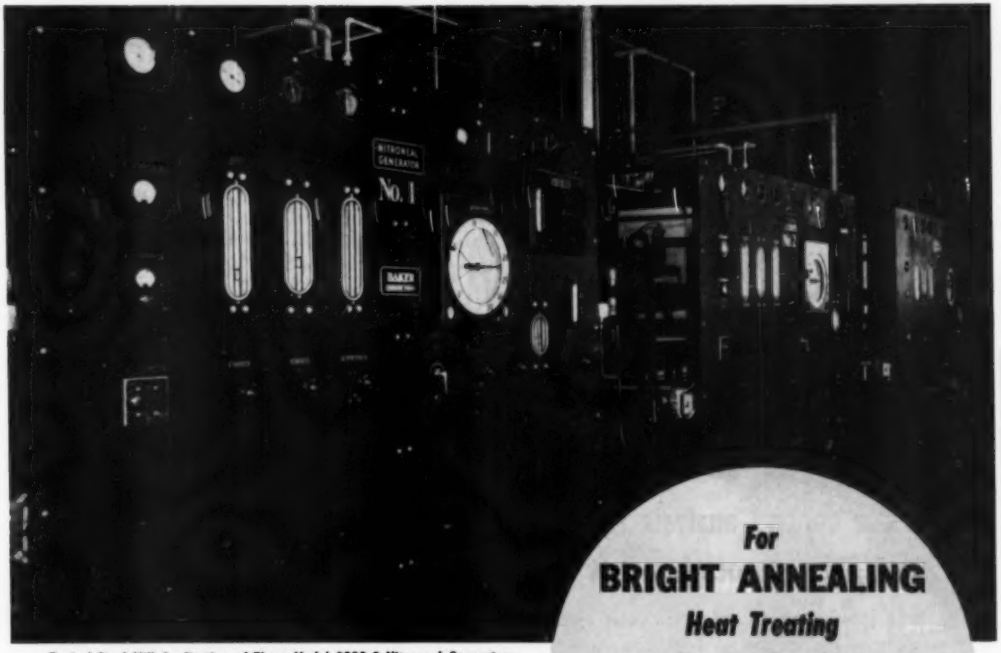

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Surface Stress in Hard Steel

(Continued from p. 200)

and hardness, it was determined that the martensite in the surface layers carried a compressive stress of 14,400 psi., and the austenite a compressive stress of 2100 psi.

SR-4 strain gages were placed on the outer surface and the tube loaded externally until the strain gage showed a 52,200 psi. tensile stress. The X-ray studies indicated that the martensite was then 37,800 psi. in tension (a change of 52,200 psi., exactly checking the strain gage) and the austenite was 53,000 psi. in tension (a change of 55,100 psi. from the original condition). The ring was then loaded further until the strain gage showed 119,100 psi. in tension; the austenite (by X-ray) then was carrying 105,000 psi. in tension — a change of 107,100 psi. from the original state. The authors believe that the yield strength of austenite is about 105,000 psi., so that this constituent acquired a permanent set. This idea is fortified by the fact that when the external load was entirely removed the strain gage registered 13,100 psi. tension (instead of zero at the start) and X-ray analysis showed the martensite to be carrying 5500 psi. compression (instead of 14,400 at the start) and the austenite to be carrying 6900 psi. *tension* (instead of 2100 psi. compression at the start).

The authors conclude that their method can give values of internal stress at and near the surface of hardened steel articles within an accuracy of ±3500 psi.

E. E. T.

Binary Molybdenum Alloys*

RESULTS are reported on the effects of various binary additions on the workability, room-temperature mechanical properties and hot hardness (up to 1470° F.) of molybdenum alloys. A total of 16 groups of binary alloys were evaluated, including alloying additions of Al, B, Be, C, Co, Cr, Fe, In, Mn, Ni, P, S, Si, Sn, Th and W.

All alloys were prepared by mixing, pressing, and sintering powder mixtures of the desired composition. Breakdown rolling of the sin-

(Continued on p. 204)

*Abstract of "Properties of Some Hydrogen-Sintered, Binary Molybdenum Alloys", by W. L. Bruckart, M. H. LaChance, C. M. Craighead and R. I. Jaffee, 1952 Preprint No. 36.

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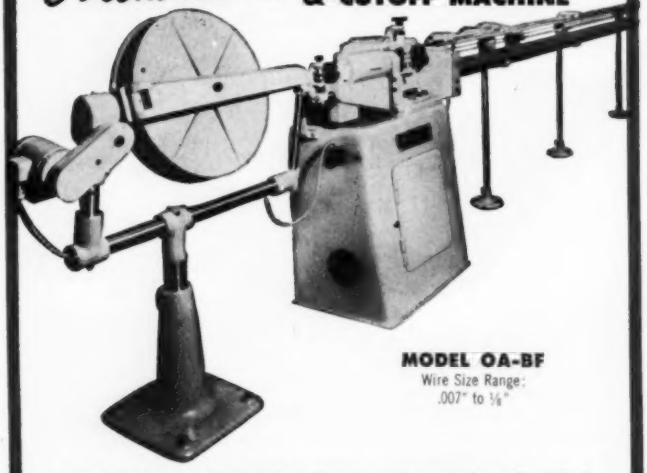

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Binary Molybdenum Alloys

(Continued from p. 202)

tered bars was usually done at 2280° F., although some alloys required higher temperatures. The standard condition for testing was the use of 0.040-in. strip which was as-finish rolled at 2280° F. and annealed for ½ hr. at 2010° F. in hydrogen. Except for hot hardness measurements, all mechanical property data were obtained from tests at room temperature.

Sintering and fabrication behavior data are presented for all alloys of the various systems studied, together with an estimate of the range of compositions that could be fabricated to strip form using the powder metallurgy method of alloy preparation.

Average values of the tensile and hardness data obtained in this study on pure molybdenum and its alloys are presented in tabular form. Of the sixteen alloying elements studied, six elements seemed to be superior to the others. These were, in the order of their strengthening effect: Si, Co, Fe, Al, Cr and W. Silicon caused the greatest decrease in ductility and tungsten the least, with the other elements showing little difference.

Hardness data taken at room temperature, 390, 930, and 1470° F., are listed in tabular form. Alloying elements producing the greatest strength also increased hardness the most. In the hot hardness tests, the greatest drop in hardness occurred between room temperature and 390° F., loss in hardness beyond this temperature being roughly linear and at a lower rate.

Metallographic studies were made on all specimens and three general types of microstructure were observed: *(a)* Single-phase elongated grain structures, sometimes partly equiaxed; *(b)* single-phase elongated grain structure containing scattered inclusions strung out in the rolling direction; *(c)* two-phase structures containing a molybdenum compound as the second phase in a matrix of elongated grains.

REVIEWER'S COMMENTS

The data presented in this paper are of considerable importance in allowing an evaluation of powder-metallurgy molybdenum alloys. Although elevated temperature properties other than hardness were not evaluated, the data presented enable one to learn with a fair degree of certainty the effectiveness

of the alloying additions studied.

Unfortunately, the effects of three elements which have been shown to be quite effective strengtheners in arc-cast molybdenum were not evaluated. These elements are zirconium, titanium, and columbium. Alloys of these materials could not be produced due to reaction with the hydrogen during the sintering operation.

Work on the evaluation of arc-cast molybdenum alloys has indicated the importance of oxygen content on workability and mechanical properties. It might prove extremely worthwhile to know the actual oxygen content of the various alloys included in this study.

For satisfactory operation at high temperatures, molybdenum alloys must either retain good strength and ductility in the recrystallized condition, or must have recrystallization temperatures high enough so that they will not be likely to recrystallize in service, thus enabling them to be used in the fibered condition. Therefore, additional studies should be made of these characteristic properties of powder-metallurgy alloys before their suitability for high temperature service is evaluated.

E. S. JONES

Plastic Stress-Strain Relations in Aluminum*

THE KNOWLEDGE of the plastic stress-strain relations in metals subjected to combined stresses is an important requirement for the solution of a number of engineering problems. To solve such problems, many engineering theories have been proposed. These theories define mathematical equations for determining the stress-strain relations for all states of combined stress based on a plastic true stress-strain relation in simple tension.

In order to determine which of the theories is most suitable, it is necessary to investigate many states of combined stress and numerous materials. Since constant stress-ratio tests cannot distinguish between the various theories, emphasis is placed on variable stress-ratio tests.

Tests were made on thin-wall tubular specimens of aluminum alloy 14S-T6 by subjecting them to inter-

(Continued on p. 206)

*Abstract of "Plastic Stress-Strain Relations of Alcoa 14S-T6 for Variable Biaxial Stress Ratios", by Joseph Marin, L. W. Hu and J. F. Hamburg, 1952 Preprint No. 24.

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Plastic Stress-Strain Relations in Aluminum

(Continued from p. 205)

nal pressure and axial tension. The reduced section of the 3-in. long specimens had a 1 in. inside diameter and a wall thickness of 0.050 or 0.075 in. Strains were measured in both the axial and lateral directions. In the elastic range, strains were measured with SR-4 strain gages, a clip gage measured the plastic strains.

Both constant stress-ratio and variable stress-ratio tests were made. Constant ratio tests included ratios of tangential to axial stresses of 0, 0.5, 1.0, 2.0 and infinity. Variable stress-ratio tests were of two kinds: *(a)* two-step tests in which a stress was applied in one principal stress direction (either tangential or axial) and then a stress was superimposed in the other principal stress direction to failure; *(b)* three-step tests in which a stress was applied in one principal stress direction followed by a stress in the other principal stress direction and finally stressing in the first direction to fracture.

The results of the tests are plotted both as nominal or conventional stress-strain curves and as true stress-strain curves, for both directions. The true stress-strain curves are compared with theoretical curves representing the flow theory of plasticity (or deformation theory for the constant stress-ratio tests). For the constant stress-ratio tests, the results are also plotted in the form of effective true stress versus effective true strain.

The proportional limit and yield strength values determined from the constant stress-ratio tests are compared with various series of failure. True fracture stresses for both the constant and variable stress-ratio tests are also compared with different failure theories.

The effect of biaxiality of stress on ductility is displayed by plotting the effective true strain at fracture for various stress ratios. These values are compared with a theoretical ductility curve calculated from the various true fracture stress values considering the effective true stress-strain relation for a biaxial stress condition to be the same as that determined from a simple tensile test.

The relatively large difference in the total strain in the two directions for a given state of biaxial stress, depending on the loading path by which that stress state was reached, is stated to support the flow rather

(Continued on p. 208)

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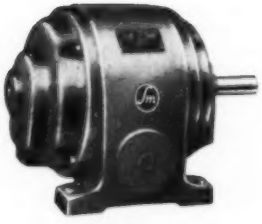

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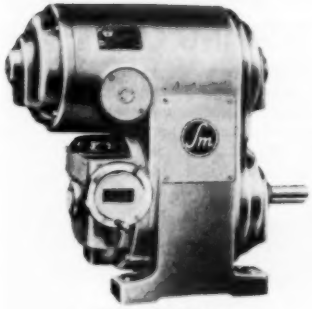

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Plastic Stress-Strain Relations in Aluminum

(Continued from p. 206)

than the slip theory of plasticity.

From the results of these tests on aluminum alloy 14S-T6 subjected to biaxial tensile stresses, the following conclusions are drawn:

1. The proportional limit values are in approximate agreement with the maximum stress theory.
2. The yield strength is in approximate agreement with the distortion energy theory.
3. The true fracture strengths for both constant and variable stress-ratio tests agree with the maximum stress theory.
4. Ductility decreases with increase in biaxiality of the stresses. The true ductility may be approximately determined by the effective strain at fracture.
5. The flow theory gives a good approximation for the plastic stress-strain relations for numerous variable stress-ratio tests conducted.
6. The variable stress-ratio test results support the flow theory rather than the slip theory.

H. N. Hill

Machinability of Titanium*

Studies of the machining characteristics of titanium and its alloys have been limited to the physical aspects of tool loads and speeds. A general conclusion in this regard is that titanium alloys are similar to stainless steel in their cutting properties.

In the belief that titanium alloys could be developed which would be more satisfactory, the hypothesis was advanced that small amounts of certain elements which would remain insoluble in titanium could improve the free-machining qualities by acting as an antifriction agent. This hypothesis was based on past work with other alloys, such as lead-bearing copper alloys and free-machining steel. When this hypothesis was applied to titanium alloys, only a few elements appeared to be suitable because so many elements are highly soluble in titanium or their vapor pressure is too high at the melting temperature of the titanium alloy.

The elements chosen on the

(Continued on p. 210)

*Abstract of "The Influence of Insoluble Phases on the Machinability of Titanium", by R. M. Goldhoff, H. L. Shaw, C. M. Craighead and R. I. Jaffee, © 1952 Preprint No. 30.

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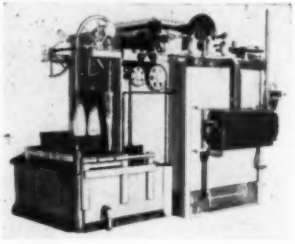

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Machinability of Titanium

(Continued from p. 208)

basis of their probable suitability were carbon, sulphur (as Ti_3S_4 and MoS_2), silicon, boron, beryllium, germanium, tellurium, selenium, phosphorus and arsenic. Alloys of these were arc-melted in an argon atmosphere. The more volatile elements were added as a master titanium alloy prepared prior to their addition to the ingot melt. The ingots were machined to chips which were remelted to insure homogeneity. The final ingots were forged into bar stock at 1750° F. and the surfaces of the bars were cleaned before being hot rolled at 1450° F. They were heated to this temperature for ½ hr., process annealed in air and then air cooled.

Both lathe cutting and band saw cutting studies were made on the special titanium alloys. Cutting indices were established relative to the cutting properties of magnesium-reduced unalloyed sponge titanium which was found to be more suitable than Type 304 austenitic stainless. The stainless steel was relatively insensitive to tool condition.

The machinability index was established essentially by the ratio of removed material as compared with that removed from the magnesium-reduced unalloyed titanium, by comparing the average feed rates under uniform conditions. The lathe machining tests were standardized at 120-lb. thrust load and 27 surface ft. per min. A 40-lb. load was used for the saw tests. Tensile strength and elongation were determined after the machining tests were made.

The tests showed that iodide-reduced unalloyed titanium was more easily machined than any of the compositions resulting from the alloying additions: its machinability index was 227 as compared with that of 100, the standard established for magnesium-reduced unalloyed titanium. This superiority is ascribed to the low carbon, oxygen and nitrogen contents in the iodide-reduced titanium. None of the alloy additions to magnesium-reduced titanium produced such free-machining characteristics as found in the pure iodide-prepared metal.

Small benefits, however, were obtained from additions of 0.05, 0.10, 0.13 and 0.29% boron; 0.118% sulphur, as MoS_2; 0.07, 0.27 and 0.47% tellurium; 0.26 and 0.51% arsenic; and 0.03% germanium. The low boron and arsenic additions produce the best improvement

(Continued on p. 212)

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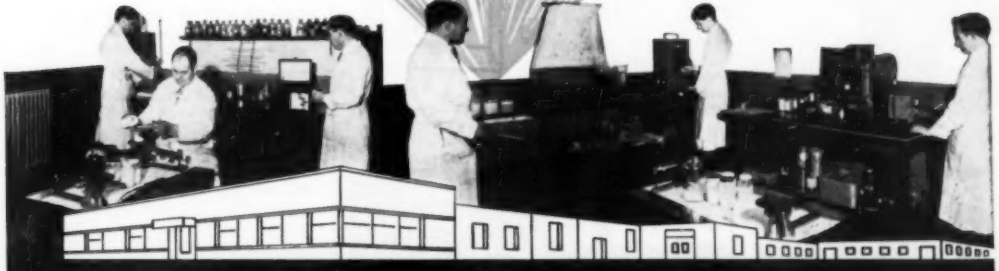

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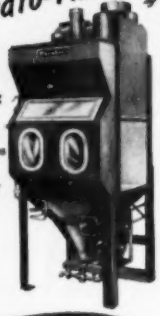

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Machinability of Titanium

(Continued from p. 210)

while carbon and silicon were definitely detrimental. The results of saw tests, except for a few insignificant differences, usually paralleled the results of the turning tests.

In general, the additives increased the tensile strength often by more than 25%, with the greatest tensile strength of 110,000 psi. being produced in the 0.09% silicon concentration. The tensile elongation and reduction of area of the alloys were usually decreased as alloy concentration increased, except for a slight increase in the alloys containing germanium and selenium additives.

Machinability was found to decrease as both the strength and hardness increased. At constant strength level, insoluble alloy phases improved machinability.

J. W. GRAHAM

Isotopic Method for the Determination of Oxygen in Metals*

THE QUANTITATIVE determination of oxygen in metals and metal oxides has long been a difficult task. The isotopic method requires apparatus as elaborate as most, a supply of oxygen-18, and the availability of a modern isotopic mass spectrometer. It does not require quantitative separation or recovery of the oxygen, and hence takes less time (usually about 2 hr.) than other methods.

The isotopic dilution principle originally introduced by Hevesy and Paneth is the basis for the method. A known weight of the substance to be analyzed and a known weight of the metal or metal oxide containing a given amount of oxygen of known O^{18} concentration are placed together in a platinum, molybdenum, or other oxygen-free tube. The tube is heated for 30 to 60 min. in the vicinity of melting point of the sample. At this temperature the oxygen atoms exchange statistically between the oxygen-containing compounds (metal oxides, CO and CO_2). The method depends upon the fact that the ratio of the oxygen isotopes (O^{18}/O^{16}) in all these oxygen-containing compounds at equilibrium is identical,

(Continued on p. 214)

*Abstract of "Determination of Oxygen in Metals and Metal Oxides by the Isotopic Method", by A. D. Kirshenbaum and A. V. Grosse, 1952 Preprint No. 39.

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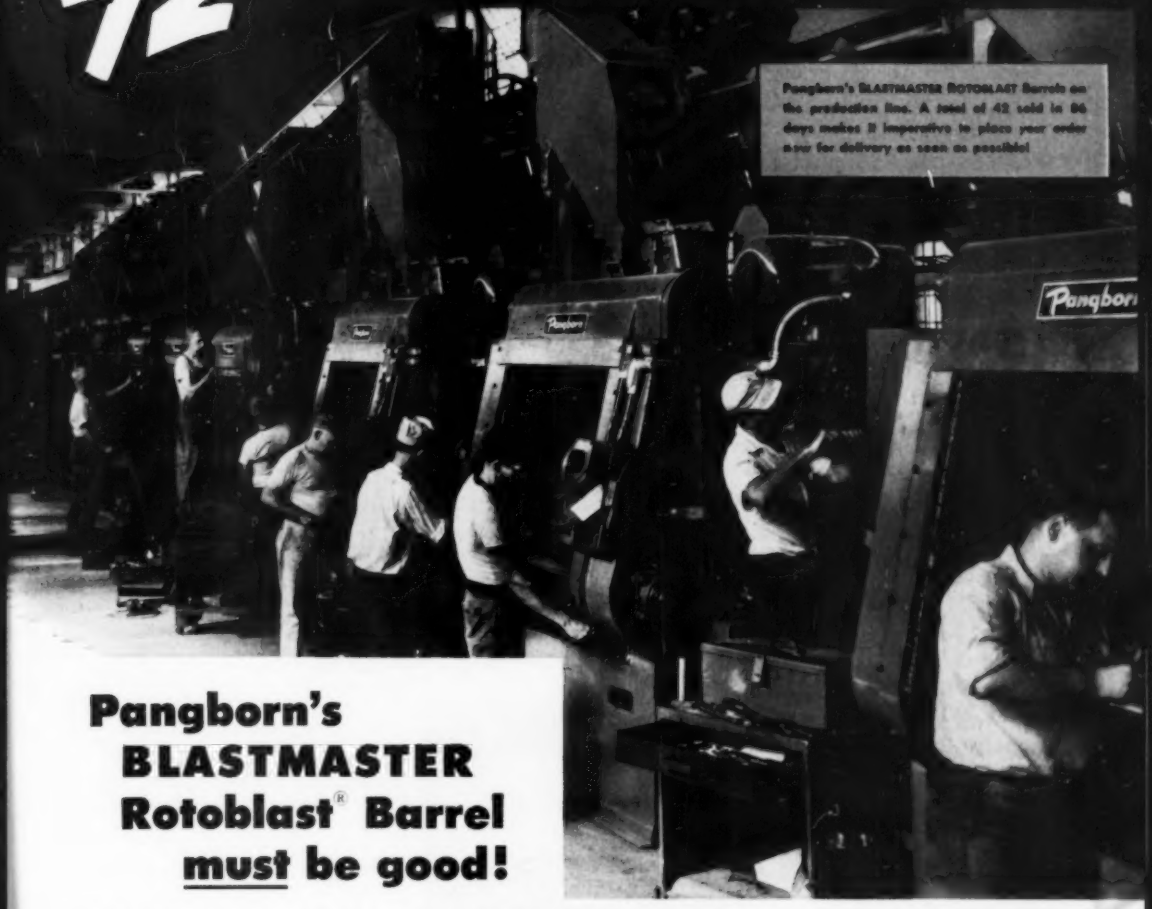
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Isotopic Method for the Determination of Oxygen

(Continued from p. 212)

and that equilibrium is attained. Heating for 30 to 60 min. near their melting points is stated to be sufficient for attaining the completion of statistical exchange of the oxygen atoms throughout the system, but the only proof of this fact presented lies in the agreement of the experimental results with the expected results.

The ratio O^{18}/O^{16} is determined with a high degree of precision by means of modern isotopic mass spectrometers. Only an aliquot sample, usually a fraction of a cubic centimeter, is needed for mass analysis. Therefore the quantitative removal of all the oxygen is not only unnecessary but even undesirable, since equilibrium between oxides and gas is desired. If small quantities of oxygen are expected, the amount of O^{18} added to the sample can be adjusted to fit.

The apparatus consists of a vacuum system for separating and sampling gases, a 6-kw. converter, and a high-frequency induction furnace.

The results of analysis by this method were not compared with the results of other methods of analyzing for oxygen but with the theoretical oxygen content, or the oxygen content calculated from the gain in weight when the sample was prepared. The results for copper and copper oxide alloys show differences as high as 0.14% and as low as 0.004%. For oxygen in iron and iron-oxygen alloys, two comparisons were given. These showed deviations of 0.029% and 0.19%.

ELIZABETH HARTNER

Delayed Yield Phenomenon*

RESULTS are presented of an investigation to determine whether the cumulative time at stress for a series of pulses was the same as the delay time required for the initiation of yielding in a single rapid loading test. The influence of aging at different temperatures for different time intervals between stress pulses was also studied.

The specimens used had a cylindrical gage section 0.1 in. in diameter by ½ in. long. Mild steel, annealed

(Continued on p. 216)

*Abstract of "A Study of the Mechanism of the Delayed Yield Phenomenon", by T. Vreeland, Jr., D. S. Wood and D. S. Clark, © 1952 Preprint No. 33.

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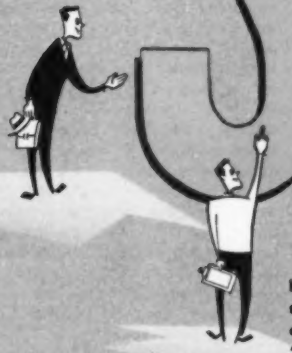

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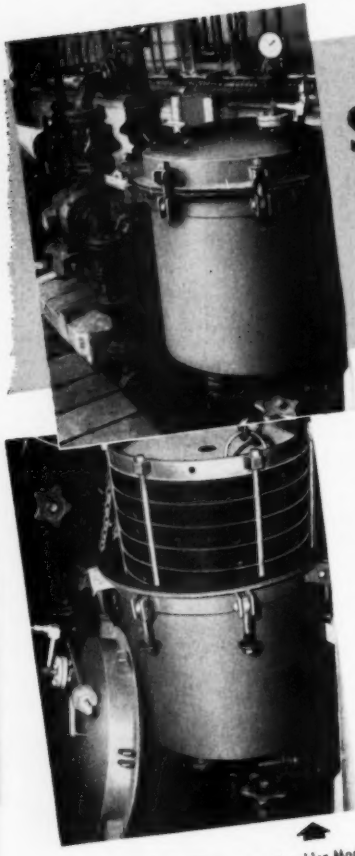

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For example: A rubber-lined Sparkler Model 8-18 filter is used by Gillette in the continuous filtration of a 1000-gallon bright nickel plating solution. Now operating for approximately two years, this filter has been on a 24 hours a day, 7 days a week schedule — without any loss of operating time for repairs or maintenance. Also used in periodic batch carbon treatments of nickel solutions this unit, according to Gillette technicians, consistently delivers a brilliantly clear effluent, even though the plates may be packed solid.

Top: Sparkler Model 8-18 filter shown installed in Gillette's plating department. Above: Same filter, with filter plate assembly being removed for cleaning

Left: Sparkler Model 8-6 stainless steel filter. This portable unit is used by Gillette to filter gold plating solutions.

Another Sparkler Filter employed by Gillette is a Model 8-6, stainless steel, portable unit. Used exclusively for cyanide type plating solutions, this Model 8-6 has proved particularly valuable for Gillette's gold plating operations since the patented Sparkler Scavenger Plate assures minimum loss of precious gold solution. Now operating almost six months for at least 2 hours daily, its performance has been satisfactory in every respect.

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Delayed Yield Phenomenon

(Continued from p. 214)

at 1680° F. in dry hydrogen for 2½ hr. and thereafter homogenized at 1300° F. for 22 hr., was used for the experiments. Tests were made with a rapid loading testing machine modified to permit stress pulses to be applied to the specimen. Strains were measured by means of SR-4 strain gages bonded to the specimen; stresses were measured by a calibrated dynamometer. Records were obtained by means of an oscillograph.

Rapid-load tension tests were made but the reader is referred to an earlier paper for a description of the method. The effect of stress pulses was investigated. The pulse was as follows: *(a)* Stress of 45,000 psi. applied in approximately 0.007 sec., *(b)* stress held constant for 0.029 sec., and *(c)* stress removed in about 0.003 sec. The delay time for the material was approximately 0.05 sec., which was greater than the duration of one pulse but less than the sum of two. Thus, the material might be expected to yield during the second pulse if there was no recovery between pulses. The specimens were aged for various time intervals between pulses at 70, 150, and 200° F. Specimens which were aged 3 min. at 70° F. yielded during the second stress pulse. Aging for 12 min. at 200° F. and 100 min. at 150° F. produced recovery, and yielding did not occur on the second stress pulse.

A mean value of microstrain equal to 30×10^{-6} in. per in. was found to occur prior to yielding. A recovery of 50% of the microstrain was observed when the stress was removed. Successive stress pulses and aging cycles showed decreasing amounts of microstrain in each stress-pulse cycle. When the aging induced recovery, the decrease in microstrain per cycle was even greater. The surface of a test specimen was polished and etched. Microscopic examination showed that no slip lines formed until yielding occurred, thereafter slip lines formed within the single Luders' band which had formed.

An activation energy of 18,800 cal. per mole was found for the recovery process. This value equals, within the limits of experimental error, the values of activation energy for diffusion of carbon and nitrogen in iron. The theoretical implications of this fact are discussed.

E. R. PARKER

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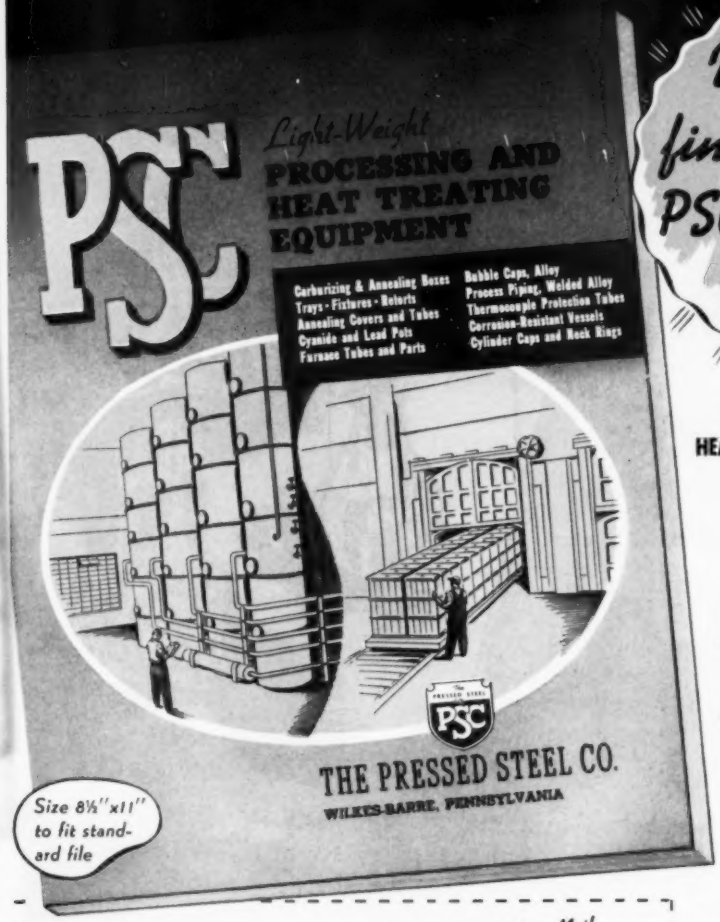

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Zirconium-Tin and Zirconium-Silicon Systems*†

PREVIOUSLY UNPUBLISHED phase diagrams of the zirconium-tin and zirconium-silicon systems have been developed during the investigation of zirconium binary alloys for the Atomic Energy Commission. Micrographic analysis of as-cast and heat treated alloys, backed by thermal and X-ray diffraction analyses were the principal tools used in determining the diagrams.

The alloys were prepared from zirconium crystal bar of 99.8% purity (low in hafnium) from hot wire decomposition of the iodide; tin and silicon used in the systems were of 99.99% purity type. The alloys were made by arc melting the components under helium atmosphere, using a tungsten-tipped electrode and holding the alloys in a water-cooled copper crucible. All alloys were inverted and remelted at least three times before opening the furnace.

The alloy ingots, weighing 20 to 30 g., were cold pressed, homogenized, cold rolled to their maximum reduction, and isothermally annealed in sealed Vycor or quartz bulbs. Quenching was accomplished by breaking the bulbs under water.

The melting points of the metals and intermetallic compounds, as well as the solidus curves, eutectic and peritectic horizontals, were determined by metallographic detection of incipient melting in samples heated and quenched in a vacuum-equipped induction furnace. Thermal analysis techniques were used independently for melting temperatures below 1650° C.

Only a few X-ray analyses were made on these systems because of the difficulties encountered in obtaining single phase systems.

ZIRCONIUM-TIN SYSTEM*

The temperature of the allotropic alpha-beta transformation of zirconium was checked in a preliminary investigation; production of two phase alpha-beta structures showed that the range of transformation extended from 851 to 868° C.; the temperature is quite close to that reported by others, so 862 ± 5° C. was accepted for diagram construction.

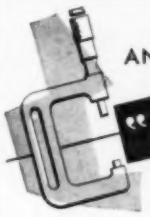
Three intermediate phases exist in this system: Zr_4Sn (24.55% Sn), forming in a peritectoid reaction between beta zirconium and Zr_5Sn_3 at 1325 ± 20° C.; a phase tentatively considered to be Zr_5Sn_3 (43.84% Sn), although the observed alloy corresponded more closely to Zr_3Sn_2 (46.45% Sn), melting with an open maximum at 1985 ± 25° C.; and ZrSn, with a likely stoichiometric composition of 56.55% Sn, that forms from a peritectic reaction between Zr_5Sn_3 and a melt containing 83% Sn at 1140 ± 15° C.

X-ray analyses of the three intermediate phases were attempted and lattice parameters were obtained for Zr_4Sn and ZrSn. No X-ray measurement on the alloy in the 45% Sn composition area was successful; the general instability of alloys in this range indicated that attempts were useless to determine whether the phase has a variable composition.

A eutectic was located at 23.5% Sn and 1590 ± 15° C. The solubility of tin in beta zirconium at the eutectic temperature was determined to be approximately 21%, decreasing to 6.5% at 980° C.; solubility of tin in

(Continued on p. 220)

*Abstracts of "The System Zirconium-Tin", by D. J. McPherson and M. Hansen, ⊖ 1952 Preprint No. 34; †"The System Zirconium-Silicon", by C. E. Lundin, D. J. McPherson and M. Hansen, ⊖ 1952 Preprint No. 41.



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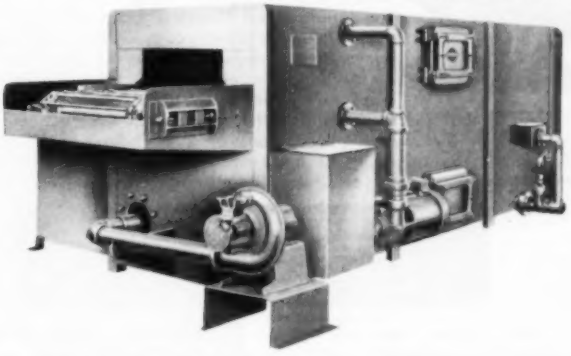

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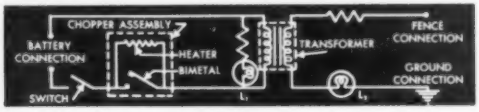

The chopper assembly consists of a straight bimetal element with contact in parallel with a resistance wire heater wound around the bimetal. Normally, the contacts are open so that initial current flows through the heater to cause the bimetal temperature to increase and move to close the contacts. This closing action shorts out the heater and decreases the temperature in the bimetal which then returns to its original open position. The current again passes through the heater to start the next operation cycle. A green light flashes during normal operation; and a red light flashes whenever the fence is grounded or the controller is shorted.

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Zirconium-Tin and Zirconium-Silicon Systems

(Continued from p. 219)

alpha zirconium was found to decrease from 9% at 980° C. to 1.5% at 600° C. The presence of tin raises the alpha-beta transformation of zirconium and gives a peritectoid reaction at 980 ± 20° C.

Ztrconium-tin alloys, particularly in the 45 to 65% tin range, must be handled with caution, as they are quite pyrophoric. Tin displays no solid solubility for zirconium.

ZIRCONIUM-SILICON SYSTEM†

Small weight percentages of silicon added to zirconium cause large shifts in the atomic percentage of silicon, this being manifest on a weight percentage diagram by a crowding of the phase fields toward the zirconium-rich end of the system. Large numbers of the alloys, differing only in small amounts of silicon by weight, were prepared for a complete study of the zirconium-rich end; also, sufficient alloys were cast to survey the entire binary system.

The effect of silicon addition on the allotropic transformation of zirconium could not be determined, as this element displays extremely limited solubility in both forms of zirconium; a eutectoid or peritectoid reaction between zirconium and silicon may result between 850 to 875° C. and at less than 0.1% silicon.

The system is characterized by seven intermediate phases, which, because of the limited range of composition, required the use of polarized light for the micrographic interpretation of structures and identification of phases; all the phases were strikingly contrasting in color.

The phases were determined to be: Zr_4Si (7.14% Si); Zr_2Si (13.33% Si); Zr_3Si_2 (17.02% Si); Zr_4Si_3 (18.74% Si); Zr_6Si_5 (20.40% Si); ZrSi (23.53% Si); and $ZrSi_2$ (38.09% Si). All are formed peritectically except Zr_6Si_5, which has an open maximum melting temperature at 2250° C.

The peritectic temperature of formation and composition of the reacting melt for each phase are: Zr_4Si, 1630° C. and 4.5% Si; Zr_2Si, 2110° C. and 9% Si; Zr_3Si_2, 2210° C. and 14.4% Si; Zr_4Si_3, 2225° C. and 18% Si; ZrSi, 2095° C. and 24.2% Si; $ZrSi_2$, 1520° C. and 46% Si.

Two eutectics were found, one for zirconium and Zr_4Si at 2.9% Si and 1610° C., the other for silicon and $ZrSi_2$ at 75% Si and 1355° C.

J. M. SIMMONS

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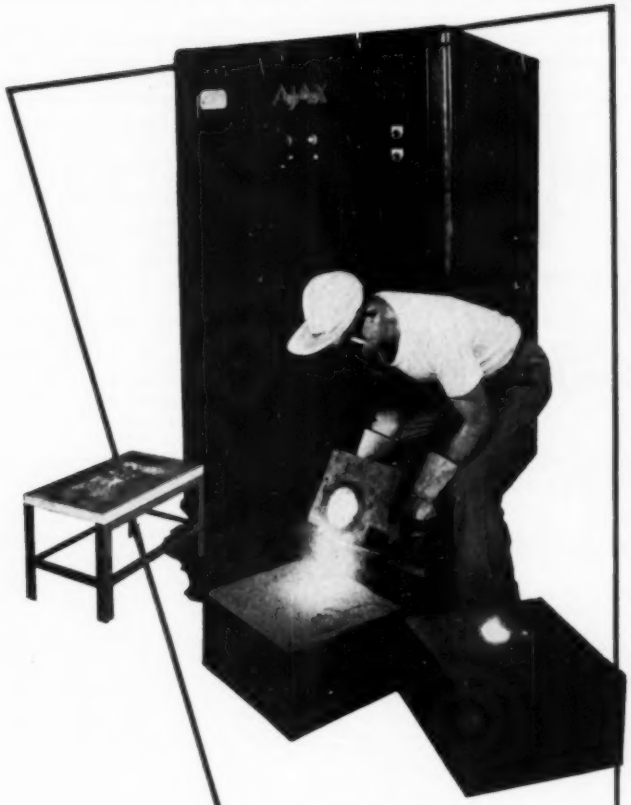

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Strain Aging Sheet Steels*

STRAIN AGING of commercial sheet and strip has long been recognized as an important factor in the deep drawability of steel. Only a few commercially important steels have been developed which effectively resist strain aging. However, since these are more expensive to produce, it is desirable to control the aging of ordinary rimmed steels.

*Abstract of "Accelerated Strain Aging of Commercial Sheet Steels", by R. L. Shoenberger and E. J. Paliwoda, © 1952 Preprint No. 20.

The object of this investigation was *(a)* to study the natural strain aging of an ordinary rimmed and two grades of nonaging sheet (aluminum-killed and vanadium-rimmed), and *(b)* to develop an accelerated test for predicting the course of age hardening and the rate and severity of yield point return during aging.

The chemistry of these steels was 0.05% C, 0.30% Mn, 0.07% P, 0.027% Si. Several heats of each grade of steel were skin-rolled from 0.6 to 1.8%, and the yield point, hardness, ultimate strength and elongation were determined periodically for 6 months as the steels strain aged at room temperature.

Considerable variations were noted in the aging characteristics of rimmed and stabilized steels, and attempts were made to ascertain the significant variables. In the rimmed steels, variations in chemistry did not appear to influence strain aging behavior. However, the finer grained steels were relatively harder, both before and after aging, and had faster yield elongation return than the coarse grained.

All of the nonaging steels were susceptible to some degree of strain aging. The principal factors affecting the aging of these steels appeared to be the ferrite grain size, the degree of skin-rolling, and the amount of uncombined nitrogen (0.0002 to 0.0024% in these steels). Higher proportional limits in skin-rolled and as-aged conditions were observed in steels having large uncombined nitrogen contents.

The dependence of strain aging on time and temperature were utilized to devise a quantitative accelerated aging test applicable to all grades of strip steel. Immediately after skin-rolling, samples were heated for various lengths of time in a temperature-gradient furnace. The gradient used for rimmed steels was 100 to 500° F., and for stabilized steels 125 to 600° F. After gradient heating, three or more Rockwell T-30 impressions were made at selected intervals along the specimen length. By comparing the average hardness at each location to the comparable hardness of the same steel during natural aging, an empirical relation was derived between time and temperature of gradient heat treatment, and time of strain aging at room temperature. In 70% of the tests, the actual and predicted hardness values at 6 months of natural aging agreed within ±1 hardness point.

The data presented by the authors, and the accelerated test developed are of definite value. If the tests were applied over a period of time to a statistical study of the strain aging of mill grades of sheet and strip, its use might well be standardized for quality control purposes. However, it is more likely that its chief contributions will come in studying the aging characteristics of experimental grades of sheet and strip. There is some question concerning the value of the hardness prediction, since the hardness changes illustrated were only of the order of 2 to 6 Rockwell T-30 over a 6-month period.

F. X. KAYSER

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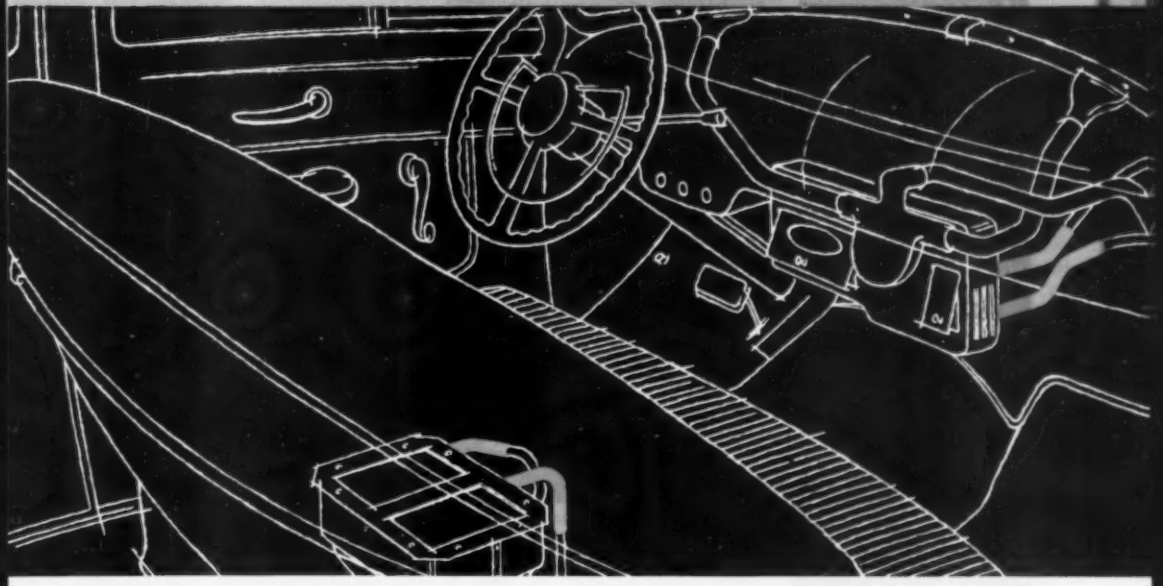

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Grain Growth in Cartridge Brass*

THIS PAPER deals with recrystallization and grain growth in cold-rolled commercially pure 70/30 brass (0.026% lead, 0.020% iron and neither phosphorus nor tin; balance zinc).

The senior author (H. L. Walker) had shown previously that when cold-rolled brass of a particular initial grain size was annealed isothermally, the recrystallized grain size r decreased with increasing deformation d in accordance with the equation

$$\log r = nd^{\frac{1}{3}} + \log m$$

where n and m are constants. The present work was done to find *(a)* whether this equation held true for different initial grain sizes, and *(b)* the effects of deformation and initial grain size on the recrystallized grain size and the heat of activation for recrystallization. The senior author and others had shown that it was reasonable to suppose that an equilibrium grain size would be reached during long annealing. Hence, data was also obtained at very long annealing times (10^7 sec.) for the purpose of deciding if an equilibrium grain size existed.

*Abstract of "Recrystallization and Grain Growth in Alpha Brass", by S. L. Channon and H. L. Walker, 1952 Preprint No. 8.

Experimental Procedure — Materials used in this work had, for each of five percentage reductions in thickness (20.5, 40.4, 61.8, 90.2 and 94.2), two initial grain sizes — one large (0.066 mm.), one small (0.004 to 0.012 mm.) as given in the tabulation. Annealing of samples cut from these materials was done in a salt bath. The times taken for the thickest (0.062 in.) to reach bath temperature varied from 16 sec. at 1290° F. to 32 sec. at 570° F.

Coil	% Deformation	Grain Size in Mm.*	Hardness R_B	Hardness Vickers
A	20.5	0.068	111	...
B	20.5	0.012	117	...
C	40.4	0.068	117	...
D	40.4	0.004	120	...
E	61.8	0.066	120	...
F	61.8	0.006	122	...
R	90.2	0.066	...	264
S	90.2	0.006	...	260
T	94.5	0.066	...	269
U	<90.2	0.006	...	260

*Average of at least 6 separate grain counts.

The course of isothermal recrystallization was followed by measurements of the hardness of samples cut from coils A to F (see tabulation), annealed at 570, 660, 750, 930, 1110 and 1290° F., and of samples cut from materials R to U and annealed at 480, 570 and 690° F. The time when recrystallization was complete was settled by microscopic examination. If slip lines or bent twin interfaces were found, the sample was considered to be in a state of strain. When such evidences of strain were absent, it was assumed that recrystallization was complete. With some tests it was hard to judge the time for complete recrystallization because structural changes occurred slowly, particularly at low temperatures. However, photomicrographs and hardness-time curves, considered together, made it possible to determine the time for complete recrystallization with reasonable accuracy.

The course of isothermal grain growth was followed by means of grain count measurements of samples (8 to 10 areas in each) annealed for times up to 128 days at 750, 930, 1110 and 1290° F. No hardness tests were made of these samples. Annealing at 1290° F. was not extended beyond 7 days because corrosive

(Continued on p. 242)

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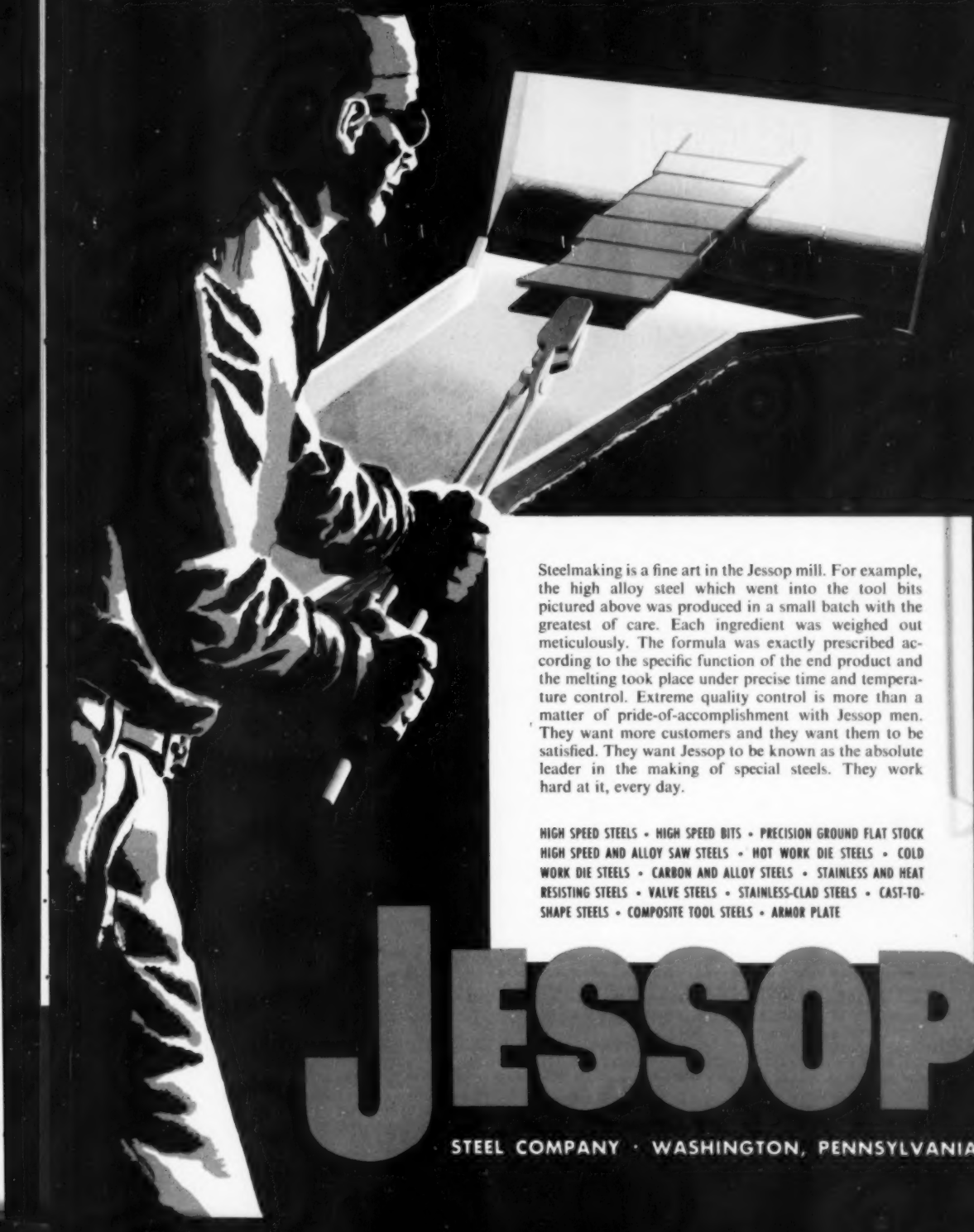

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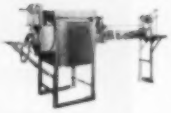

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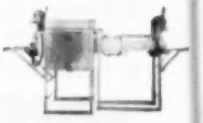

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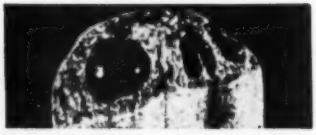

WITHOUT WELDALUMINITE — Photomicrograph of cross-section view of a weld on Rimmed Steel, without the application of WELDALUMINITE. Note the excessive porosity . . . an extremely weak weld . . . will finish poorly.

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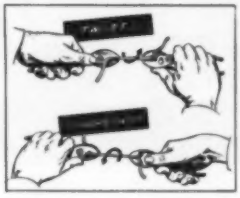

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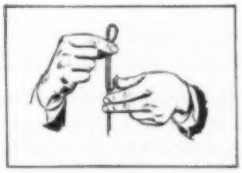

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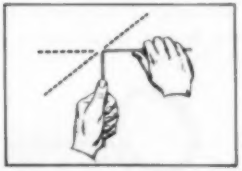

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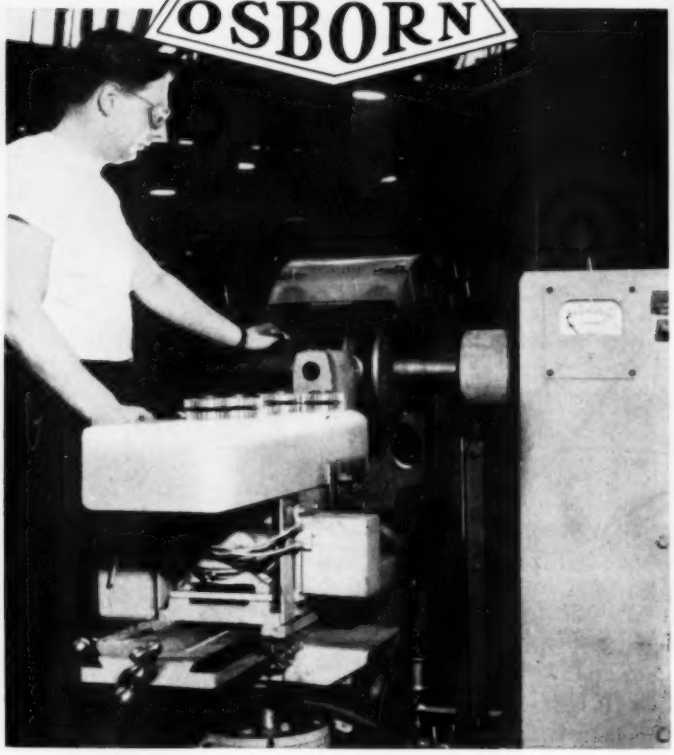

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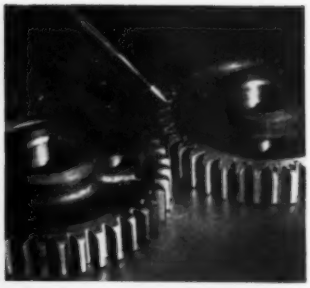

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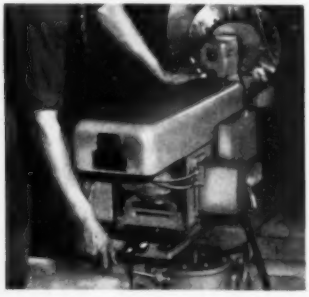

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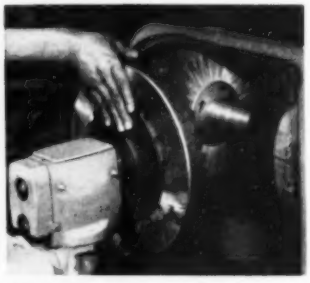

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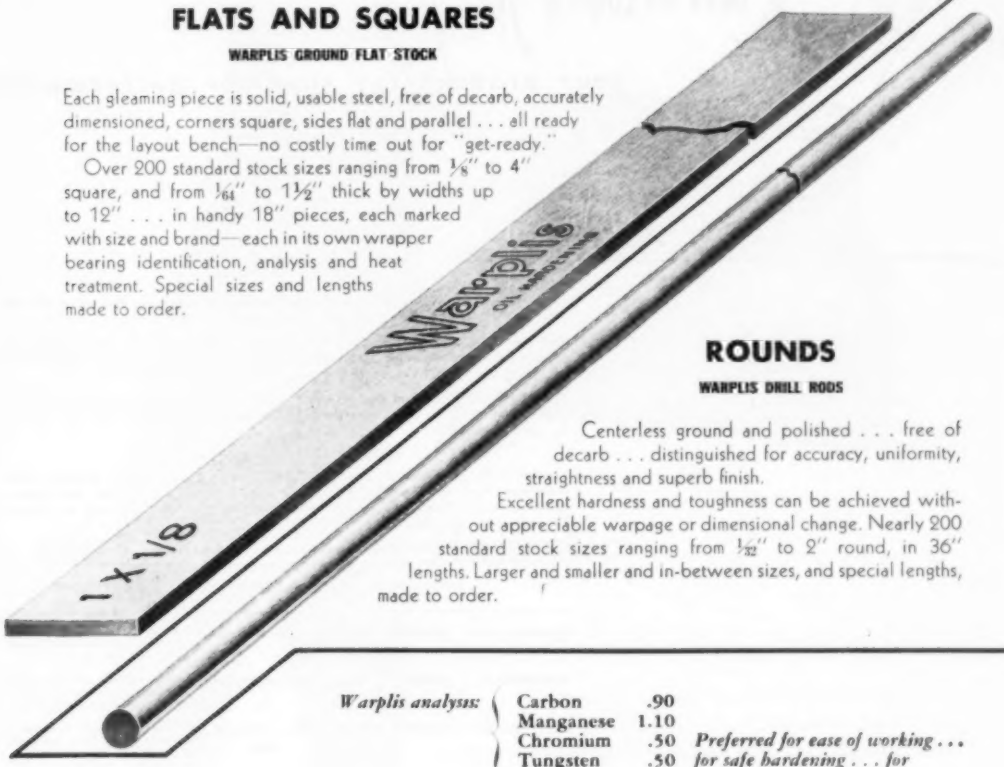

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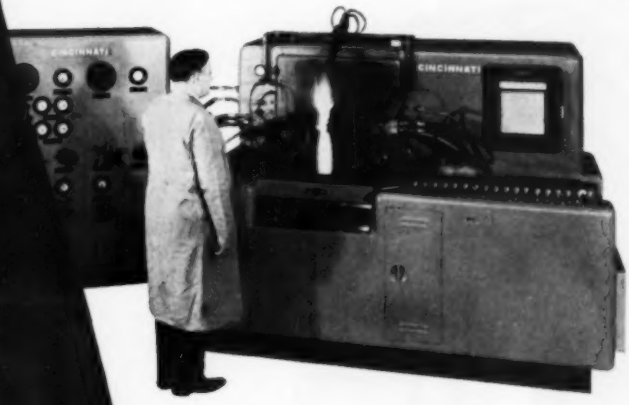

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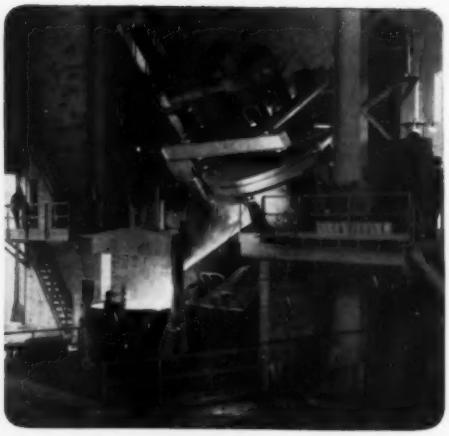

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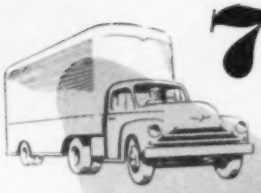

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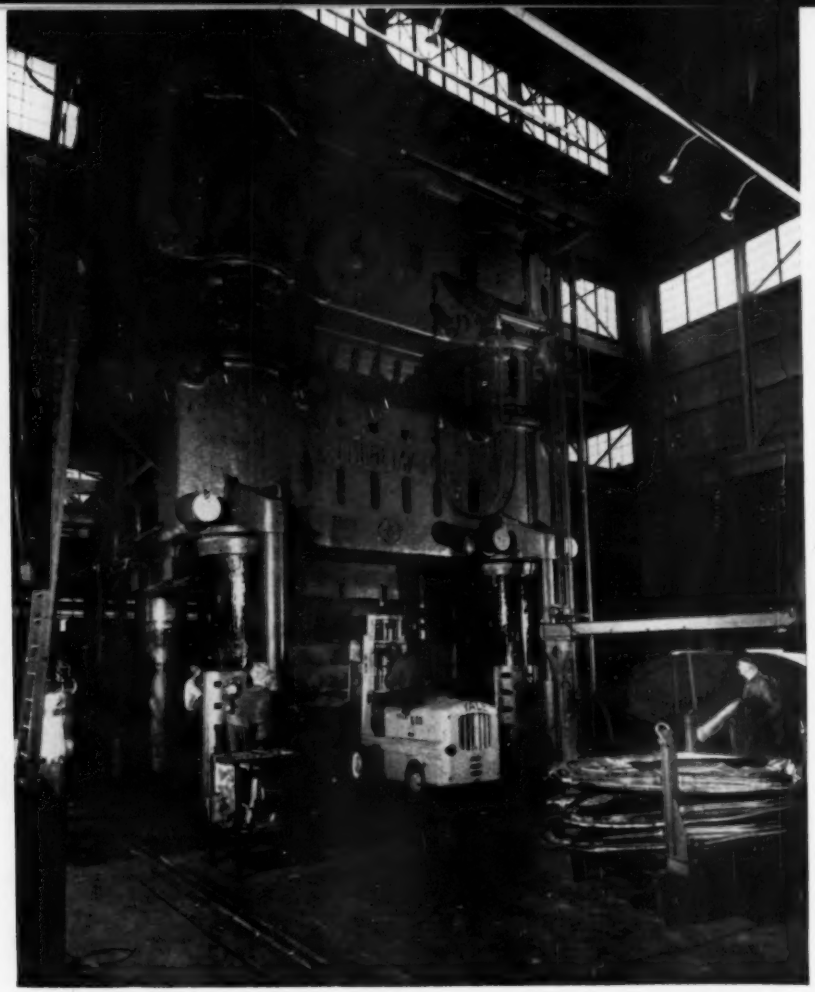

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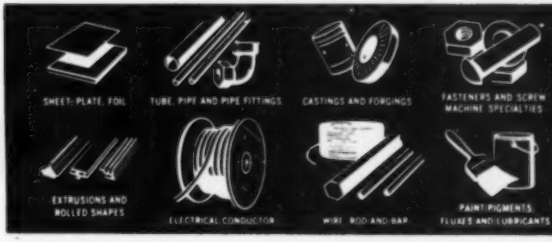

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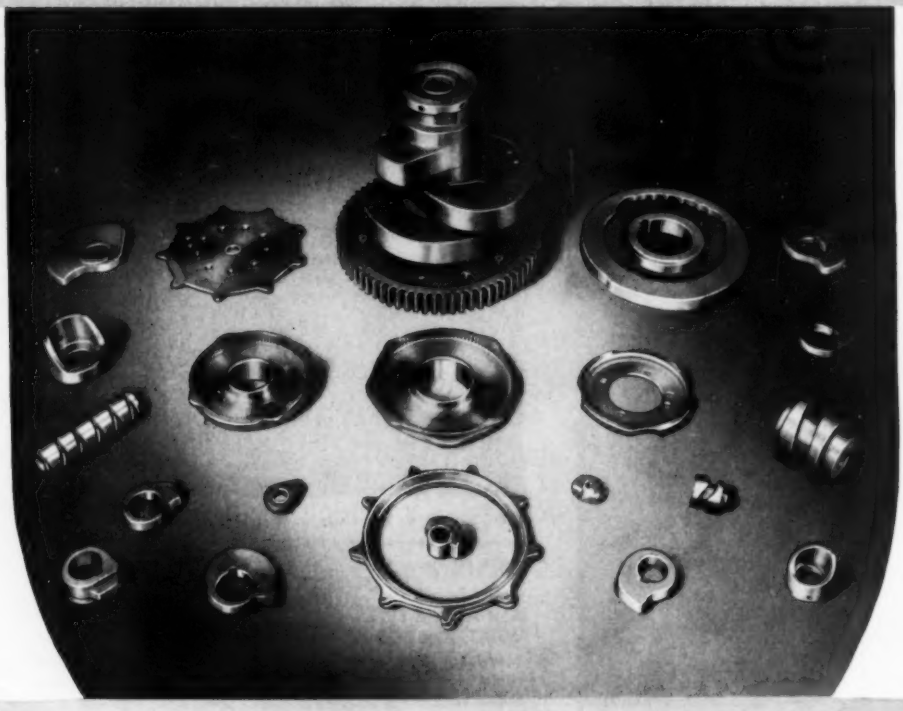

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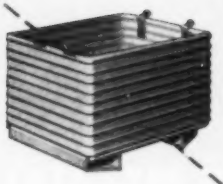

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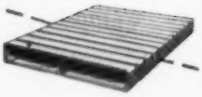

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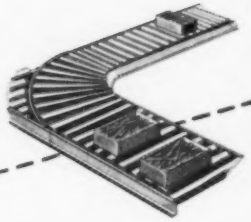

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The JETAL PROCESS is a simple, inexpensive immersion method for blackening ferrous metals by oxidation.

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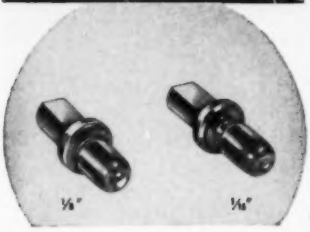

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Grain Growth in Cartridge Brass

(Continued from p. 224)

attack of the samples was excessive.

Experimental Results — At temperatures of 930 to 1110° F., isothermal recrystallization often was complete before the samples reached bath temperature, and in others it was complete soon after bath temperature had been attained. The annealing time for complete recrystallization was found to be shorter for samples having greater amounts of deformation, as well as for the higher annealing temperatures and smaller initial grain sizes; the hardness after annealing was higher the greater the deformation, the lower the annealing temperature and the smaller the initial grain size.

The relationship between recrystallized grain size and deformation d, referred to in the introduction, was confirmed for materials of different initial grain size — the constant m was found to be a function of the initial grain size. Recrystallized grain size r and initial grain size i can be related as follows

$$r = b\, i^{a}$$

where b represents a function of the deformation.

Isothermal grain growth data did not support the view that an equilibrium grain size existed at the higher annealing temperatures, although the curves for the log grain size – log annealing time at 1120 to 1290° F. tended to level out at long annealing times. For practical purposes, grain growth may be regarded as a continuing process, at least for temperatures up to about 1290° F. and annealing times of less than 128 days. The grain size after long annealing times is essentially independent of the amount of prior deformation or initial grain size. There is evidence to support the view that the simple linear relationship suggested by Beck, Towers and Mauley ("Grain Growth in 70-30 Brass", *Metals Technology*, Vol. 15, February 1948) as describing grain growth completely does not hold in this case, at least at an annealing temperature of 1100° F.

The heat of activation for grain growth for this material was found to be 61 kilocalories per mole; it was independent of prior deformation and initial grain size. This value agrees very well with the heats of activation of 64 and 60 kilocalories per mole and that of 61.5 kilocalories per mole found by other workers.

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188	338	700	1250	1800
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213	363	800	1350	1900
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Creep and Rupture of Austenitic Stainless*

RESTRICTIONS in the use of some alloying elements normally added to austenitic stainless steels for service at elevated temperature has promoted considerable interest in the use of recent modifications of these steels. The present paper reports the creep and rupture properties and the effects of long-time exposure at elevated temperatures on room-temperature properties of austenitic 18% chromium, 8% nickel stainless steels with and without additional alloying elements. This paper also supplements a previous paper by the same authors, "Creep and Rupture of Several Chromium-Nickel Austenitic Stainless Steels", *Transactions*, American Society for Metals, Volume 42, 1950, p. 935-980.

The modifications of stainless steels investigated included Types 304L (304L having high nitrogen), 316L, 316Cb, 303, 304, 321 and 347. These materials were received as hot rolled bars and were annealed by rapid cooling from 1900 to 2000° F. prior to machining and testing. Some of the heats of the stabilized stainless steels, Type 316Cb, 321 and 347, were also tested after a stabilizing treatment at 1550 to 1600° F. for 2 hr.

The occurrence of creep at elevated temperatures makes it necessary to select the working stress within two limitations. The operating stress must be selected so that the total deformation will not exceed a certain value, or the stress must be such that rupture will not occur. In terms of the stress to cause rupture in 1000 hr., Type 316 in the annealed and in the stabilized condition was the strongest at 1100° F. At 1300° F., Type 316Cb annealed was the strongest, followed by Types 316 and 316Cb stabilized. At 1500° F., Type 316 was strongest, with annealed or stabilized Type 316Cb slightly weaker. Of the remaining steels tested in creep-rupture, Type 347 was next strongest followed by 316L, 321, 304, 304L.

In terms of a minimum creep rate of 0.0001% per hr., the steels containing molybdenum (excluding the low carbon grade) and columbium were strongest at 1100° F. These were followed by Types 303, 321, 304L with high nitrogen, 316L, 304 and 304L. As the temperature increased beyond 1200° F., the Type 347 weakened rapidly and Types 316 and 316Cb became the strongest. While Type 304L was the weakest at 1100 and 1300° F., Type 321 was weakest at 1500° F.

These tests at elevated temperatures have shown that carbon is very effective in improving high-temperature properties. Because of the pronounced effect of carbon, it is apparent that caution must be used in the substitution of the low-carbon Type 304L for Type 321 and 347 in applications at elevated temperatures. Nitrogen also improved the creep strength at 1100 and 1300° F. but had a deleterious effect at 1500° F. It was noted that Type 303, which is seldom used for high-temperature service, was superior to Type 304 at 1100° F. and similar to Type 304 at 1300 and 1500° F. Definite conclusions as to the relative merits of Type 321 and 347 could not be drawn, although 347 appeared to be stronger in the intermediate temperature range of 1100° F.

Tensile, notch-impact and hard-

(Continued on p. 246)

*Abstract of "Creep and Rupture of Chromium-Nickel Austenitic Stainless Steels", by E. J. Dulis, G. V. Smith and E. G. Houston, © 1952 Preprint No. 7.

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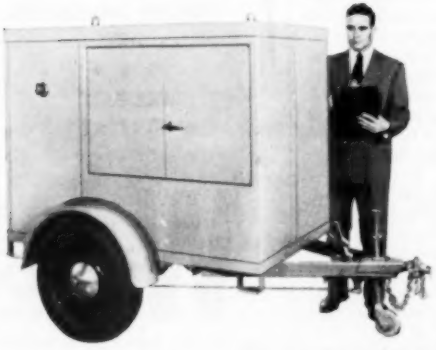

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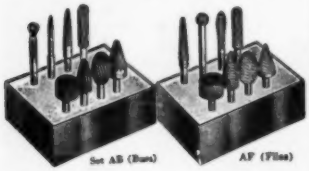

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Creep and Rupture of Austenitic Stainless

(Continued from p. 244)

ness tests at room temperature were made after 3000-hr. exposure in the creep tests. The most pronounced effect of exposure was the decrease of notch-impact strength, elongation and reduction of area. The greatest decrease in notch-impact strength was in Type 316Cb; relatively slight changes occurred in Type 304.

Microscopic examination was made of each stainless steel tested, prior to and after exposure in the creep test. The formation of sigma and carbide precipitation were the principal microstructural changes observed. Type 316Cb had the greatest loss in notch-impact strength and had the most sigma.

The authors have recognized that additional heats of these materials should be tested so that the reproducibility of properties for the modified grades of austenitic stainless steels can be determined. Only one or two heats of any one grade of stainless steel were tested in this investigation. It is possible that tests of additional heats may indicate variations not uncovered in the present investigation. R. E. LOCHEN

M_s Temperature of Titanium Binary Alloys*

A CONSIDERABLE number of alloying elements promote or stabilize the high-temperature beta phase of titanium. Increasing quantities of these beta stabilizers progressively lower two important reaction temperatures. One is the equilibrium temperature of the beta-alpha transformation which is operative during slow cooling. The second is the M_s, or martensite starting temperature, of the martensite-like reaction which occurs during the quenching of certain titanium alloys and results in the transformation of at least some of the beta to supersaturated alpha, generally referred to as alpha-prime.

The M_s temperature is independent of cooling rate. Duwez has determined it as a function of binary alloy content for a number of beta stabilizers. In order of decreasing effectiveness in lowering the M_s temperature, these elements are

(Continued on p. 248)

*Abstract of "The Martensite Transformation Temperature in Titanium Binary Alloys", by Paul Duwez, © 1952 Preprint No. 35.

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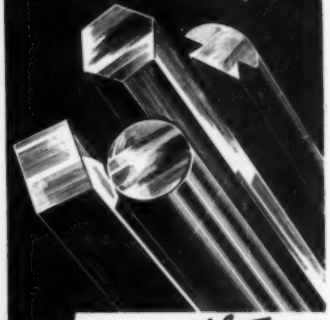

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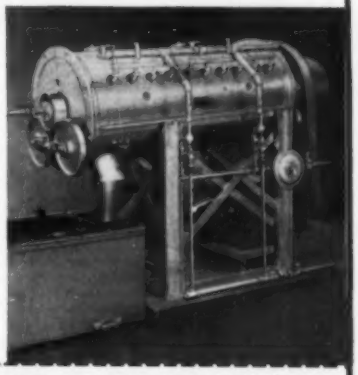

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M, Temperature of Titanium Binary Alloys

(Continued from p. 246)

iron, manganese, chromium, molybdenum, vanadium, tungsten, columbium and tantalum.

Confirming earlier work, Duwez found that an increase in the content of the beta-stabilizing alloy was also accompanied by a decrease in the relative amount of beta which transformed to alpha-prime during quenching. In all binary alloys that were studied, the content of the beta-stabilizing alloy finally reached a concentration at which all the beta was retained at room temperature after quenching. The M_s curves extrapolated to these concentrations which, for the elements studied, were reported in the literature or were found to be: Fe, 3 to 4%; Mn, 6.4%; Cr, 6.5%; Mo, 12%; V, 15%; W, 20 to 25%; Cb, 36%; and Ta, 40 to 50%.

Clearly, the elements vary widely in their beta-stabilizing power. Since all-beta alloys offer certain advantages over other titanium alloys, this is of considerable interest. Duwez did not investigate the mechanical properties of any of the alloys he studied, but it is known that all the above-mentioned alloys up through 12% Mo are quite unstable, that is, that exposure for a few hours at a temperature of only several hundred degrees will cause some of the retained beta to transform and cause embrittlement.

Duwez attempted to relate the location of the martensite transformation curve to the difference in atomic diameter between titanium and the solute element. No such relationship was found and the explanation for the varying effect of the different beta stabilizers on the martensite transformation curve has yet to be established.

W. L. FINLAY

Elastic Constants of Some Rare Metals*

ULTRASONIC INSPECTION — NOW fairly widely used — depends on the fact that it is possible to induce elastic disturbances (waves) inside a metallic solid and to register their reflections. By suitable choice of transmitter, such waves

(Continued on p. 250)

*Abstract of "The Determination of the Elastic Constants of Metals by the Ultrasonic Pulse Technique", by Myron B. Reynolds, © 1952 Preprint No. 28.

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Elastic Constants of Some Rare Metals

(Continued from p. 248)

may be either "longitudinal waves" (wherein the atomic displacements transmitting the impulses are parallel to the direction of propagation) or "shear waves" (wherein the displacements are perpendicular to the direction of propagation). Suitable crystals are also available which act as receivers of these waves at points of emergence. If the specimen is of optimum size (about 1 in. dia. and 3 or 4 in. long, and whose ends are ground, parallel surfaces) the velocity of the wave, the modulus and the density are related by the following simple equations:

$$\mu = \rho V_S^2$$

$$\text{and } Y = \rho V_L^2$$

where μ = shear modulus of elasticity
Y = Young's modulus
ρ = density
V_S = shear wave's velocity
V_L = longitudinal wave's velocity

If, now, such a metallic specimen has pressed against one end a transmitter crystal which induces a longitudinal wave and an appropriate receiver crystal at the other, pulses will be registered by the latter of waves which have passed from a to b (Fig. 1). Slightly divergent waves at the edges, starting as at f, are reflected when they intersect the surface, some of the energy continuing longitudinally along gn but some of it being "polarized" into shear waves which are deflected at a high angle along gh. Meeting the opposite surface at h, again, some of this shear wave may be reflected as such, along hk, but some of it is repolarized into longitudinal waves and proceeds along the path hi.

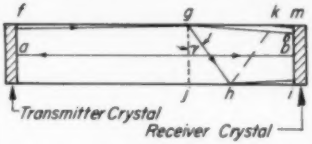

Fig. 1 — Propagation of Elastic Waves in a Cylindrical Rod

The appearance of these impulses as they reach the receiver crystal and are registered on the oscillograph screen is as in Fig. 2, where t_0 is the time the original impulse leaves the transmitter crystal.

(Continued on p. 252)

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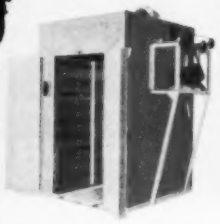

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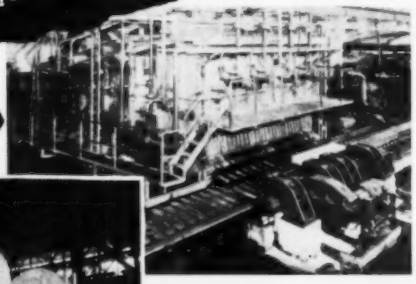

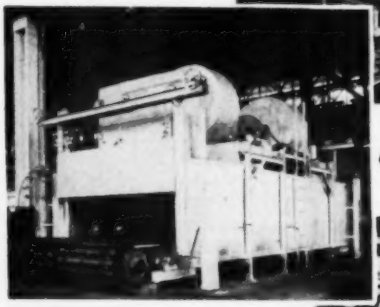

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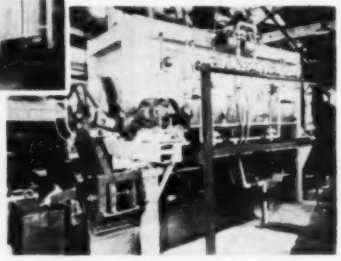

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Elastic Constants of Some Rare Metals

(Continued from p. 250)

$t_0 t_1$ represents the time required for longitudinal waves such as ab and fgn to pass the length of the specimen. $t_0 t_5$ represents the time for the first echo — that is a to b, back from b to a, and return from a to b. $t_0 t_8$ represents the time for the second echo — a → b → a → b → a → b. Time t_2 is the arrival of a pulse via f → g → h → i, part longitudinal, part transverse. T_6 is its first echo and t_9 its second. Time t_3 is a pulse arriving by a path in which two conversions to the shear mode take place along the way, as f → g → h → k → m; t_7 is its first echo. Obviously if the dimensions and density of the test piece and the electrical characteristics of the pulse apparatus are known, a pattern such as Fig. 2 enables the two moduli and Poisson's ratio of the metal to be computed by nondestructive test on a single sample.

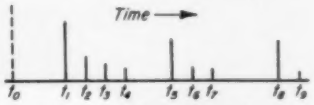

Fig. 2 — Pulses Received on Oscillograph Screen. t_9 represents time of transmission

Using this technique, Mr. Reynolds determined Young's modulus for alpha brass as 13,600,000 psi., and for Type 347 stainless steel as 28,400,000 psi. ● *Metals Handbook* reports 15,000,000 and 28,000,000 psi. respectively, from stress-strain curves on tensile specimens. The author is unable to explain the discrepancy for brass. His value for vanadium (18,400,000 psi.) is also less than Kinzel's figures of 21,000,000 to 22,500,000. His value of 15,400,000 for titanium is closer to the *Metals Handbook* figure of 16,800,000 psi.

Values for some less common metals in millions psi. are:

Metal	Young's Modulus	Shear Modulus
Beryllium	44.8	21.3
Zirconium*	12.8 to 13.9	4.76 to 5.24
Columbium	15.1	5.44
Uranium	25.5	10.2
Thorium	10.6	4.06

*Three cylinders from U. S. Bureau of Mines.

Not enough information is available to explain for the generally lower values obtained by the ultrasonic pulse technique than those from tensile tests used by other investigators.

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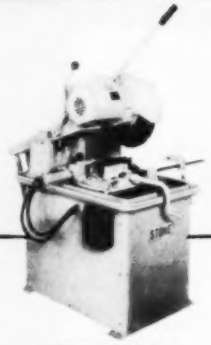

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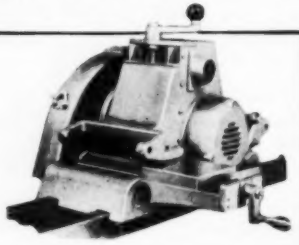

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Properties of Pure Zirconium and Zirconium Alloys*

ALTHOUGH OXYGEN has long been realized to be a potential alloying element for zirconium, this paper marks the first systematic approach to the problem and could well be copied for a similar study of the more publicized titanium. The laboratory work and procedures used in collecting data are excellent and the results set a new standard for the evaluation of the zirconium now being produced.

Iodide-reduced zirconium rods of high purity were reduced to about ⅛-in. thickness, cut into 3-in. lengths and treated with oxygen at 1930° F. in an all-glass vacuum apparatus to produce alloys containing from 0.02 (base material) to 0.42% oxygen. Degassing in high vacuum prior to the oxygen treatment was an important part of the process and produced material with Rockwell A-21 — about one atomic per cent of hydrogen was removed. In this connection, McQuillan's work on the transition point as determined by the hydrogen pressure method is omitted.

The 0.2% yield strength which rises from about 13,000 psi. for 0.02% oxygen to 53,500 psi. at 0.422% oxygen explains, in part, the wide variation in previously reported values for the tensile strength of zirconium. In all probability the erratic elongation values arise from the crystal imperfections in the original iodide rod. Elongations as high as 44% in 1-in. gage lengths were found in the pure degassed metal; these dropped to less than 4% at an oxygen level of 0.36%.

Hardness tests of these alloys show that the greatest hardening effect comes with the first oxygen additions. This is in line with tensile and hardness values reported by the Bureau of Mines on magnesium-reduced zirconium containing about 0.08% oxygen.

Alloys containing up to 0.25% oxygen are capable of being cold reduced 72%. One of the most surprising results of this work was that oxygen had little or no effect on the recrystallization temperature of the worked material.

Ultimate tensile strength of the oxygen alloy decreased from about 51,000 psi. at room temperature to

(Continued on p. 256)

*Abstract of "Some Properties of High-Purity Zirconium and Dilute Alloys With Oxygen", by R. M. Treco, Preprint No. 38.

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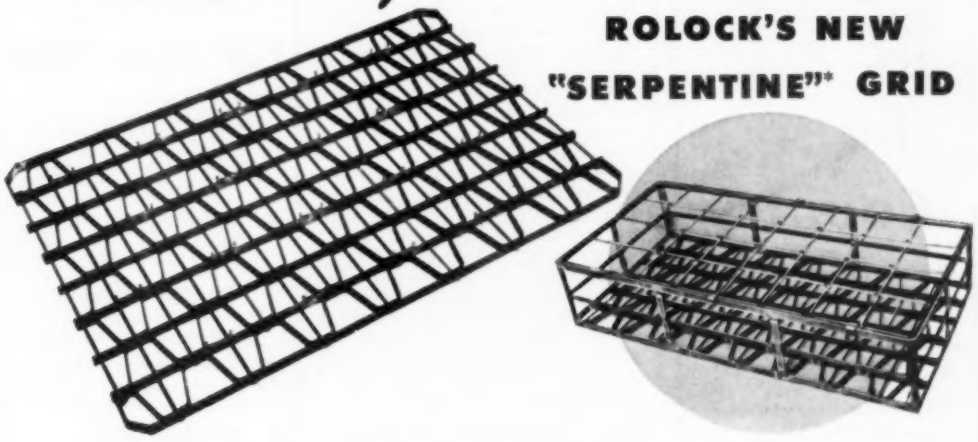

Rolock engineers have designed this distinctly different "Serpentine" alloy grid to meet the rigid requirements of modern heat treating practices. It is very light in weight, yet capable of performing with minimum distortion for an extremely long service life . . . *never previously attained.*

Simple in design and fully articulated with loose tie rods, the grid is constructed with longitudinal bars as principal load carrying members, spaced with serpentine-like intermediate bars which serve to maintain vertical alignment.

Versatility of application is shown above. Inconel tray with positioning lugs used for copper brazing taurus assemblies at 2050°F. Basket, also of Inconel, used for annealing, quenching and acid pickling steel components in a continuous cycle. Full details on application.

*Patent applied for

Rolock Booth No. 1810, National Metal Exposition, October 20-24, 1952, Philadelphia, Pa.

Offices: PHILADELPHIA, CLEVELAND, DETROIT, HOUSTON, INDIANAPOLIS, CHICAGO, ST. LOUIS, LOS ANGELES, MINNEAPOLIS, PITTSBURGH

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Pure Zirconium and Zirconium Alloys

(Continued from p. 254)

about 15,000 psi. at 750° F. Similarly, the pure metal decreased from about 31,000 to 13,000 psi. Elongation values under all conditions were satisfactory. The results show that although the oxygen alloy is stronger at all testing temperatures, it loses strength more rapidly than the pure metal with increasing temperatures, until at about 750° F. there is little difference in tensile properties. EARL T. HAYES

Temper-Brittle Steel*

PURPOSE of this investigation was to determine whether or not temper embrittlement, as measured by loss of Charpy notch-bar toughness, had any effect upon the fatigue properties of unnotched and notched specimens. Apparently none of the earlier work had been complete enough to show whether the fatigue strength of notched specimens was adversely affected by temper embrittlement. In this study, the endurance limit of a S.A.E. 5135 steel was determined at room temperature and at −35° F. and notched and unnotched specimens were tested. Different batches of the steel were heat treated to the same hardness level, but one batch was made ductile, the second received the standard temper brittle treatment of furnace cooling from the tempering temperature, while the third was made brittle at room temperature.

The fatigue tests were run on Moore-type rotating beam machines which were operated at about 8000 rpm. Room-temperature endurance limits of 77,000 psi. for nonembrittled and 75,000 psi. for embrittled specimens were obtained; notched-bar endurance limits at the same temperature were 44,000 psi. for the former and 43,000 psi. for the embrittled specimens. At −35° F., unnotched specimens had endurance limits of 81,000 psi. for the nonembrittled and 83,000 psi. for the embrittled; notched specimens had limits of 44,000 psi. for the former and 49,000 psi. for the latter. The conclusion was that temper embrittlement has no effect on the endurance limit of steel even at cold temperatures. E. R. PARKER

*Abstract of "The Endurance Limit of Temper-Brittle Steel", by R. D. Chapman and W. E. Jominy, © 1952 Preprint No. 23.

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Sharply reduced maintenance costs and wear on equipment.

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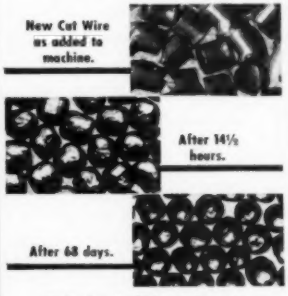

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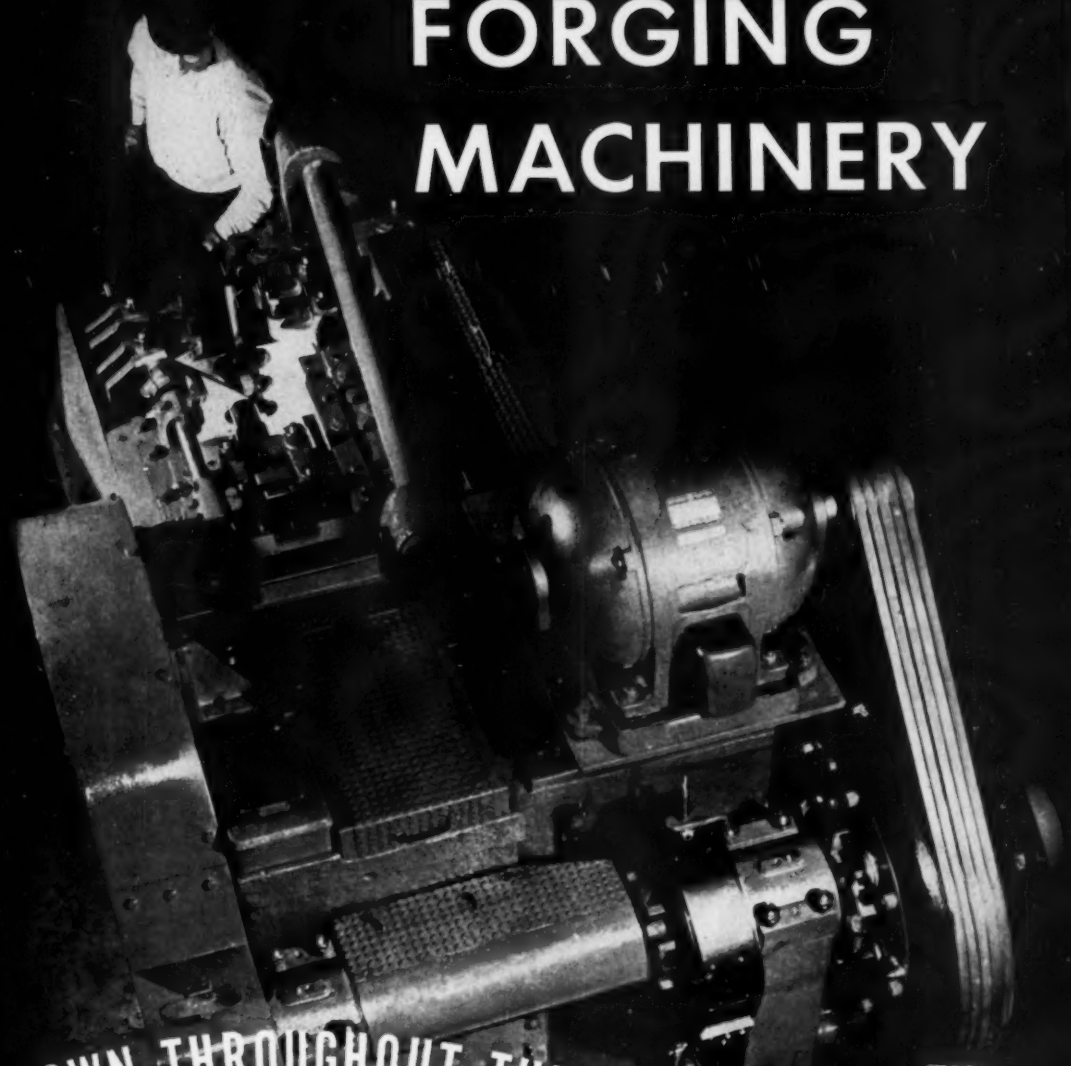

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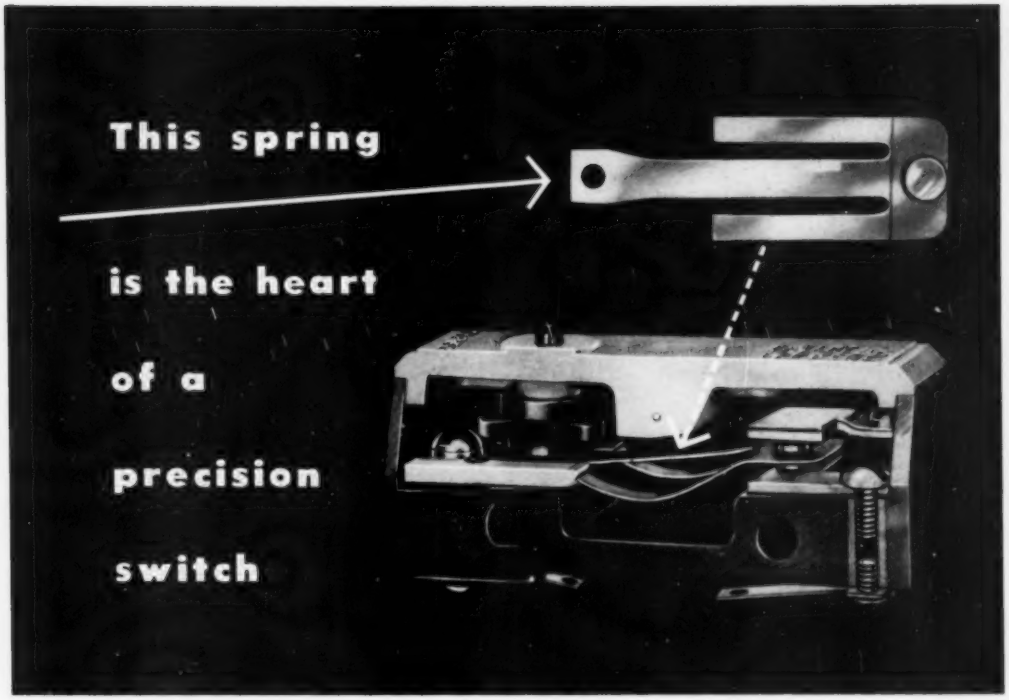

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Designed for dependable operation over millions of cycles, this unit—manufactured by the Micro Switch Division, Minneapolis-Honeywell Regulator Company—is used in the most exacting modern equipment. In critical industrial applications, these switches control machine tools, business machines, instruments and materials handling equipment. In the present defense effort, they play an equally important role in weapons, ships, planes and tanks.

Berylco beryllium copper made possible the design of these switches. Berylco's high endurance strength permits the necessary spring action to be crowded into the required space. Its ability to be hardened after forming permits a one-piece blade. Its greater uniformity permits more constant operating characteristics.

The basic switch, shown here, has an Underwriters' listing of 15 amp., 125, 250 or 460 volts ac. Recent switches, so small that it takes 265 to make a pound, are rated at 5 amp., 125 or 250 volts ac. These are only two of some 5,000 catalog items which can be produced inexpensively and in mass-production quantities because of the desirable properties of Berylco beryllium copper.

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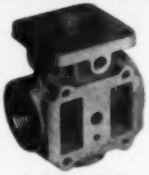

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For many years the foundry of Thompson's Light Metals Division quietly cast thousands and thousands of hard-to-make precision parts in light alloys of aluminum and magnesium for customers in the automotive and aircraft fields.

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In retorts, hearths, chain, centrifugally cast tubes and many others, Fahrite castings prove their practical heat-resisting ability. Whatever your operating conditions, a Fahrite engineer will recommend the proper-grade alloy to fill your requirements.

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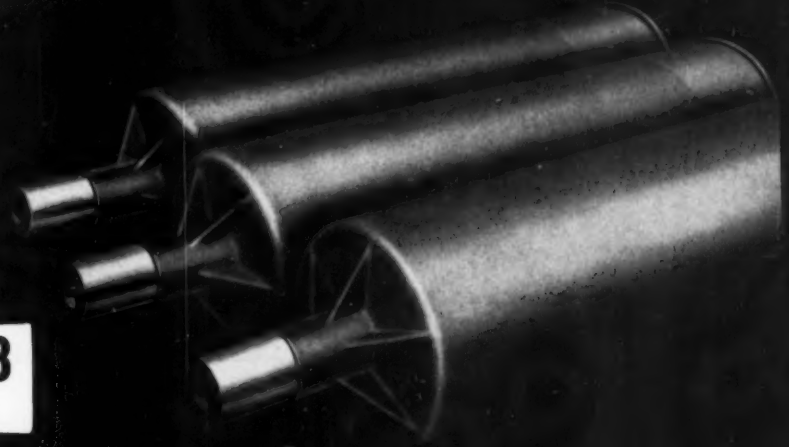

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With INCONEL heat-treating fixtures...

you take the dents out of accidents!

After a furnace pile-up in one plant recently, the fixtures looked pretty hopeless.

Some were bent and broken, like the one shown at the top. Others were flattened almost beyond recognition.

Ordinarily, scrapping the lot would be a logical thing to do. Fixtures don't last forever, and these had been used six months in an infiltration process involving a hydrogen atmosphere and 2000° temperatures.

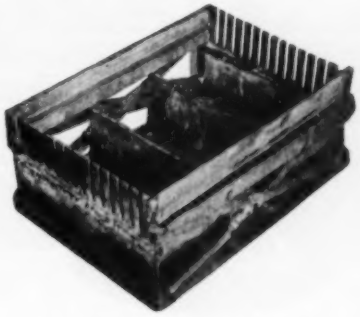
But these were Inconel® fixtures! Despite the severe service they had seen – and the accident that had knocked them flat – they could be repaired. *The metal itself showed no sign of deterioration.*

So back the fixtures went to the ALLOY ENGINEERING COMPANY, of Berea, Ohio, who had designed and fabricated them. They had no difficulty in reconditioning them, and the fixtures are now back in service. The user says they are as good as new.

And the cost? Just 25% of the price of replacement fixtures!

With Inconel, stories of salvage operations like this are not unusual. And neither are remarkable service records. For Inconel is a tough, long-lasting metal that resists corrosion, embrittlement and destructive oxidation at temperatures up to 2200° F.

READY for the scrap pile?



NO! – Repaired and back to work!

In heat-treating service, Inconel fixtures have outlasted others by as much as ten times.

Look over your own heat-treating installations. You may find many places where Inconel can help make substantial long-range savings possible.

Right now, of course, Inconel – like all Inco Nickel Alloys – is on extended delivery because of defense needs. And Government orders still restrict its use for certain types of heat-treating applications. So it is important to mention service temperatures and conditions, as well as NPA rating and other end-use information, when you order.

If you have a special problem, and would like the assistance of our High-Temperature Engineers, ask us to send you a copy of "The High-Temperature Work Sheet." This specially designed form makes it easy for you to describe your individual problem.

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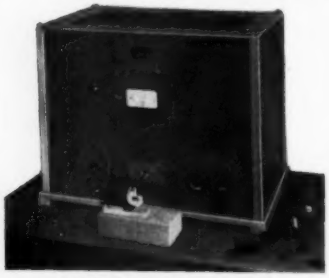

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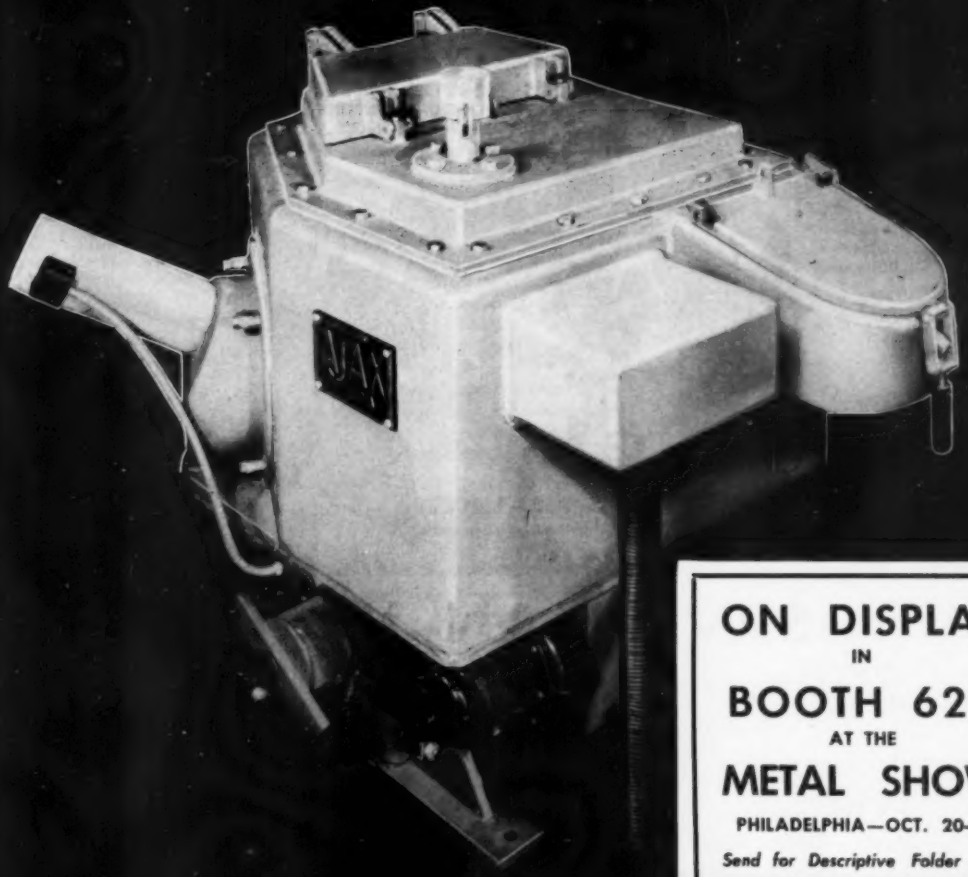

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Technical Service Data Sheet
Subject: PROTECTING ALUMINUM WITH ALODINE®

"ALODINE" No. 100

"Alodine" No. 100 forms an amorphous phosphate surface on aluminum which is thin, tough, durable, non-metallic, continuous with and a part of the basis metal. The "Alodine" film anchors paint, prolongs paint life, and protects aluminum exposed unpainted to the atmosphere.

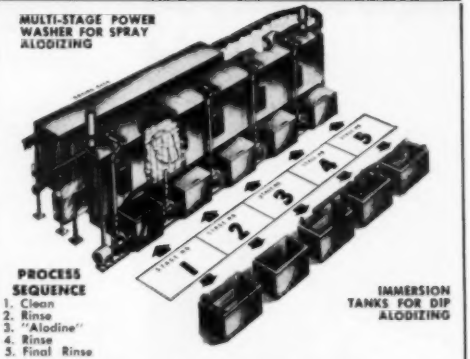
With the "Alodine" No. 100 bath at its normal temperature of 120° F., coating time by immersion approximates 1½ minutes —and by spraying, 15 to 20 seconds. Coating times and bath temperatures can be varied to suit operating conditions.

"ALODINE" No. 600

"Alodine" No. 600 forms corrosion-resistant coatings that provide excellent protection for unpainted aluminum and also make an effective paint-base. This grade is recommended for use in place of "Alodine" No. 100 on aluminum parts that are to remain unpainted or to be only partly painted; and on *all* aluminum castings and forgings whether or not these are given a paint finish.

"Alodine" No. 600 is applied at room temperature (70° to 120° F.). Recommended coating times are ¾ to 5 minutes for an immersion process and 1 to 1½ minutes for a spray process.

"ALODINE" FLOW SHEETS



NOTE: Equipment can be of mild steel throughout, except the "Alodine" stage which must be of acid-resistant material.

COATING DATA	"ALODINE" NO. 100	"ALODINE" NO. 600
COMPOSITION	Amorphous phosphate.	Amorphous mixture of metal oxides and chromates.
COLOR	Depending on alloy treated, color range is from an iridescent blue-green to a dark slate grey.	Depending on time of treatment, color range is from golden iridescent to light brown.
THICKNESS	From 0.01 to 0.08 mil. No appreciable dimensional changes occur when aluminum is Alodized.	From 0.005 to 0.01 mil. No appreciable dimensional changes occur when aluminum is Alodized.
WEIGHT	50 to 300 mgs. per square foot. Optimum: 100 to 200 mgs. per square foot.	35 to 50 mgs. per square foot.
SOLUBILITY	Insoluble in water, alcohol, solvents, etc. Insoluble in most dilute acids and alkalis. However, strong acids and alkalis which attack aluminum may penetrate the "Alodine" film and react with the underlying metal. Slightly soluble in concentrated nitric acid. Soluble in molten sodium nitrate, etc.	Insoluble in alcohol, water, solvents, etc. Soluble in strong alkalis and acids.
ELECTRICAL PROPERTIES	High dielectrical resistance.	This coating is electrically conductive. Aluminum coated with "Alodine" No. 600 can be shielded-arc welded or spot welded.
HEAT STABILITY	Unimpaired at temperatures that melt aluminum.	Unimpaired at temperatures that melt aluminum
FLEXIBILITY	Integral with and as flexible as the aluminum itself. Can withstand moderate draws.	Integral with and as flexible as the aluminum itself. Can withstand moderate draws.
ABRASION RESISTANCE	Approximately 90% of that provided by chromic acid anodized aluminum.	Approximately 90% of that provided by chromic acid anodized aluminum.
CORROSION RESISTANCE	Painted—superior to chromic acid anodizing. Unpainted—comparable with chromic acid anodizing. Meets MIL-C-5541 and other Government Finish Specifications.	Exceeds requirements of MIL-C-5541 and even AN-QQ-A-696a (anodic films)
PAINT-BONDING	Excellent. Equal to or superior to anodizing. Meets MIL-C-5541 and other Government Finish Specifications.	Excellent. Meets MIL-C-5541 and other Government Finish Specifications.
TOXICITY	Non-toxic.	Non-toxic.
BIMETALLIC CORROSION RESISTANCE	Shows good resistance against bimetallic or galvanic corrosion.	Shows good resistance against bimetallic or galvanic corrosion.

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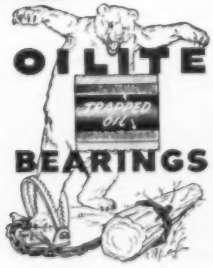

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Oilite Products Include: Bearings, Finished Machine Parts, Cored and Solid Bars, Permanent Filters and Special Units.

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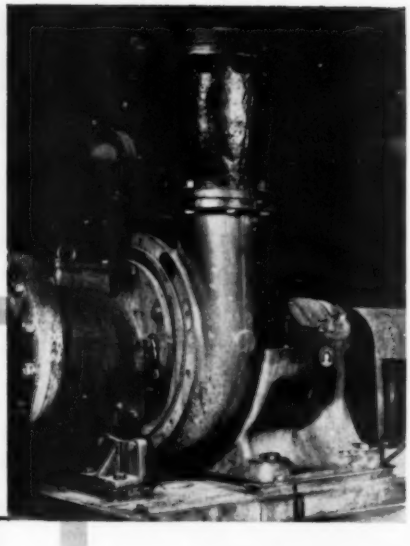

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Plus High Machinability

For every application in which you need top resistance to corrosion—plus the high MACHINABILITY necessary to apply this corrosion-resistance most economically—investigate Republic ENDURO Stainless Steel . . . in cold finished or hot rolled bars, and in wire.

Free-Machining ENDURO bars are cold finished by Republic's Union Drawn Steel Division to provide close tolerances, accuracy of section, uniform soundness and fine surface finish . . . plus the high physical and chemical properties of stainless steel. Two grades are fully 90% as machinable as Bessemer screw stock!

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The dramatic story of the discovery of stainless steel . . . how early production problems were solved . . . how the long-lasting metal grew to its present-day importance. Republic Steel's new film is available for showing to qualified groups, without charge. Requires 16mm sound projector. Send name of organization or group, type of projector, requested date, to: Ideal Picture Corp., 65 East South Water Street, Chicago 1, Ill.; or write Republic Steel, Dept. K, Cleveland 1, Ohio.

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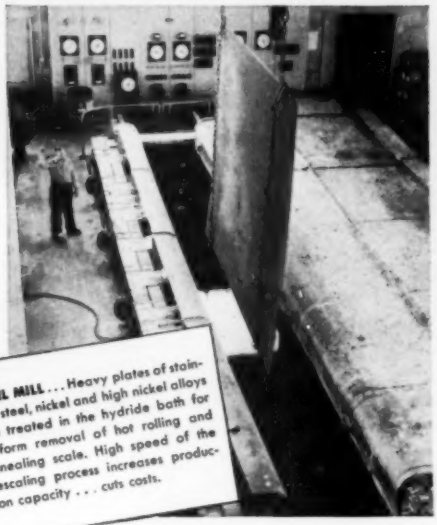
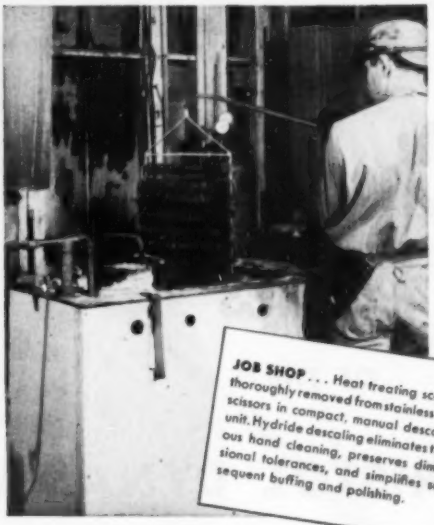


STEEL MILL . . . Heavy plates of stainless steel, nickel and high nickel alloys are treated in the hydride bath for uniform removal of hot rolling and annealing scale. High speed of the descaling process increases production capacity . . . cuts costs.



JOB SHOP . . . Heat treating scale is thoroughly removed from stainless steel scissors in compact, manual descaling unit. Hydride descaling eliminates tedious hand cleaning, preserves dimensional tolerances, and simplifies subsequent buffing and polishing.

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FROM OUNCES TO TONS! That's the capacity range of current sodium hydride installations in mills, factories and job shops of all sizes. And with each unit, the same results—speedy, uniform descaling of many different metals at a saving in time and material. Hydride descaling leaves surfaces clean and bright . . . does not attack base metal. Yet, scale is thoroughly removed from even the most intricate part by the penetrating bath action.

FOR MORE INFORMATION about the Du Pont Sodium Hydride Descaling Process, just get in touch with our nearest district or sales office or send the coupon below to: E. I. du Pont de Nemours & Co. (Inc.), Electrochemicals Department, Wilmington 98, Delaware.

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- **HIGH-SPEED OPERATION**—Descales in shortest practicable time cycle . . . can be adapted to manual, convayorized or continuous operation.
- **NO LOSS OF BASE METAL**—Bath action is reducing. Reaction stops when oxygen is removed from scale, eliminates pickling losses, etching and pitting.
- **ECONOMICAL TO OPERATE**—Permits savings in acid and metal . . . handles large volume of work in small space . . . is non-electrolytic.
- **HANDLES DIFFERENT METALS**—Alloy steel, stainless steel, nickel, copper, titanium and cobalt bearing alloys can be efficiently descaled—even in the same bath.
- **UNIFORM DESCALING**—On all surfaces without need for special racking procedures.
- **USES LOW-COST EQUIPMENT**—(Carbon Steel Tanks). NO HYDROGEN EMBRITTLEMENT.

E. I. du Pont de Nemours & Co. (Inc.)
Electrochemicals Department
Wilmington 98, Delaware

Please send me more information on the Du Pont Hydride Descaling Process: advantages, applications, equipment used. I am interested in cleaning_____products.

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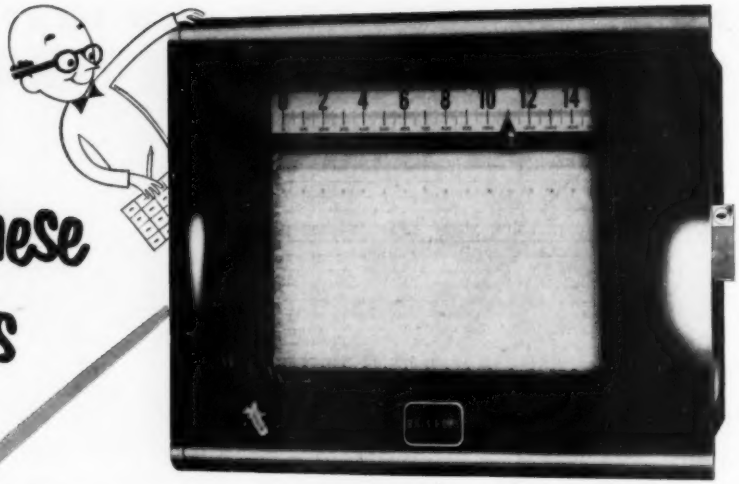

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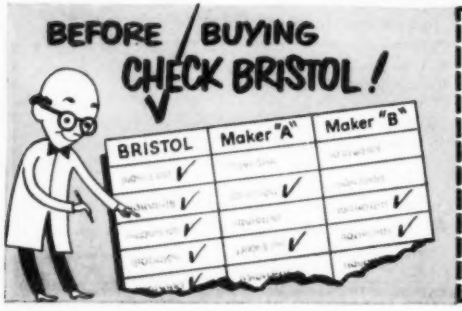

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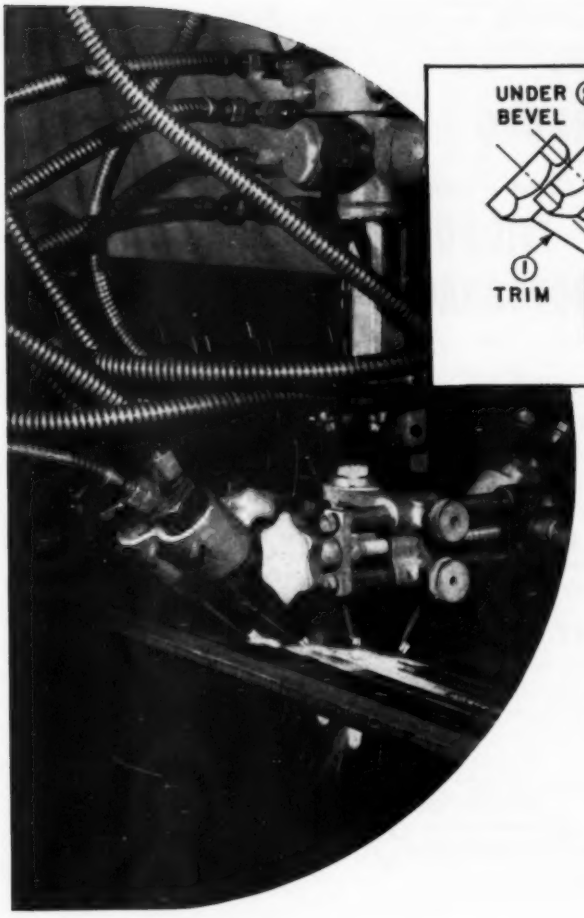

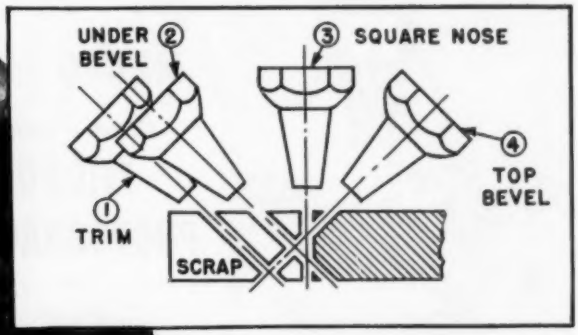

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Swift-moving oxy-acetylene flames prepare steel plate edges for welding in a fraction of the time required by mechanical methods. Multiple nozzles, cutting in different planes simultaneously, slash with ease through any commercial thickness. *Just one pass to "finish" dimensions* turns out a square edge, single bevel, single bevel and nose, double bevel, double bevel and nose, or J-groove and nose. Edge preparation costs tumble; production booms.

LINDE's oxygen-cutting methods are simple and flexible. They are economical and easy to use. They cut plates so smoothly and accurately that *no machining is necessary*—edges are ready to weld "as cut". Rigid fit-up and contour specifications are easily met. Yet, initial investment in OXWELD flame-cutting equipment is only a fraction of that for comparable machine tools. Upkeep over the years is extremely low.

On-the-job power needs are negligible. Reaction of cutting oxygen with hot steel does all the work. Only fractional horsepower is required to move the cutting nozzles along a straight line, radius, or any guided path over the line of cut.

For further details, telephone or write today. LINDE AIR PRODUCTS COMPANY, a Division of Union Carbide and Carbon Corporation, 30 E. 42nd St., New York 17, N. Y. Offices in Other Principal Cities. In Canada: Dominion Oxygen Company, Limited, Toronto.

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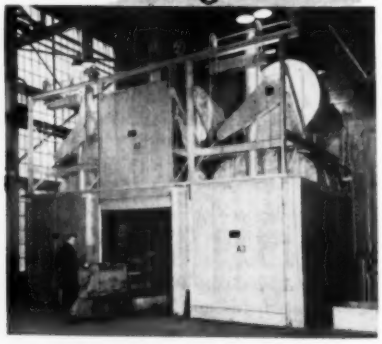

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Products at the Metal Show

(Continued from p. 19)

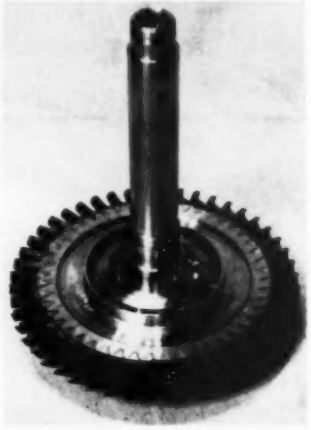
One section contains the conventional controls for the Ajax-Tama-Wyatt inductor and is used for accurately maintaining the metal temperature. The other section contains precision electronic timers and heating controls pertaining to the automatic pouring. The weight of the casting is selected on a dial in this section, and repeated automatically from then on. The normal range is for castings from ½ to 5 lb.

For further information circle No. 925 on literature request card on p. 32B

SPECTROGRAPH: Applied Research Laboratories' "Quantometer" accurately measures as many as 25 elements in an alloy, up to 20 simultaneously. This spectrochemical instrument records permanently in less than 2 min. the percentages of the elements present.

For further information circle No. 926 on literature request card on p. 32B

SUPER ALLOYS: Two Haynes Stellite super alloys, Hastelloy C and Multimet, are being used at critical



points in the first gas turbine engine installed on an American naval ship. The light weight, compact T-400 engine uses investment cast Hastelloy C nozzle vanes and turbine disks forged from Multimet alloy.

For further information circle No. 927 on literature request card on p. 32B

DYE PENETRANT: Dy/Chek dye penetrant, a product of Turco Products, Inc., permits the location of surface evident flaws with a four-step method. Any size or shape part is

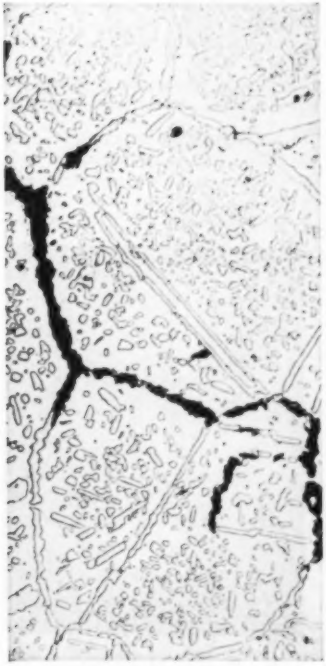
Inco High Temperature Research Note:

CARBURIZATION

...and its effect on metals at high temperatures

IN chemical processing, petroleum refining, steam power generation and other work at high temperatures, metals are often exposed to atmospheres that may have unsuspected corrosive effects.

Common soot, itself, can seriously damage the usefulness of some heat-resisting alloys. When carbon diffuses into the grain boundaries, it embrittles the metal.



Under the microscope, this specimen reveals the reason why a carburizing box broke after 2200 hours of service at 1860° F. The thick black lines are the hard carbides which intruded along the grain boundaries and oxidized, causing embrittlement of the metal.

From INCO Research Laboratory, Case Report No. 5082.1.

This is one form of destruction that can be caused by carburization.

It may be a tolerable condition in some applications. Where the metal is subjected to impacts or sudden temperature changes, however, carburization can be the reason for premature failure.

The susceptibility of an alloy to damage by carburization seems to depend on the relative amounts of iron, chromium and nickel in the alloy. Nickel resists carburization. As a result, nickel-base alloys show excellent resistance to this form of high temperature corrosion.

There are some additions to this general observation:

For example, high chromium steels with a ferritic structure do give good resistance to carbide formation. The practical limit on their usefulness, however, is the loss of strength they suffer at temperatures above 1300° F.

With exceptions like this in mind it is apparent why a considerable background of information is necessary to predict the performance of alloys at high temperatures.

That is why INCO'S metallurgists are continually investigating the behavior of alloys in the field and in research laboratories at Bayonne, N. J., and Huntington, West Va., to make more of this information available to industry through Inco's High Temperature Engineering Service.

Their creep and rupture tests at temperatures as high as 2100° F. supply data on the strength properties of high nickel alloys. Their studies of corrosive attack by various hot atmospheres, fused salts and molten metals provide the type of information that helps industry to select more suitable, longer-lasting materials for various high temperature applications.

When high temperature performance is a problem to you (or when you expect it to be), Inco High Temperature Engineers may have the answer for you. They have devised a special High Temperature Work Sheet on which you can set down your problem. Write for your copy now.

Send for your copy of this new High Temperature Work Sheet; it simplifies gathering the full story of your problem.

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"In keeping with the high standards we wished to attain for Calcinator, we chose 'Sicon.

Under rigid perfection tests 'Sicon' was found to have:

1. High resistance to heat when exposed to temperatures ranging from 400 to 500°F.

2. Exceptional color as well as gloss retention qualities.

In addition, only 'Sicon' had good inherent qualities of adhesion and film stability."

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Deluxe Calcinator, the home incinerator so smart looking that it can be placed right in the kitchen. Finished in SICON White.

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SICON STANDS UP WHERE OTHER HEAT-RESISTANT FINISHES FAIL!

In case after case, for product after product, SICON has proved to be the *only* heat-resistant finish to pass all tests—in the laboratory and on the production line.

Sicon, in smart decorative colors, now opens up a new horizon for design engineers, because only Sicon makes it possible to combine "eye appeal" with retention of color and gloss in the presence of sustained heat.

No matter how rigid your heat-resistant finish requirement, *try* Sicon, the original silicone-base finish that has revolutionized product finishing wherever high temperatures pose a problem.

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MIDLAND INDUSTRIAL FINISHES CO.

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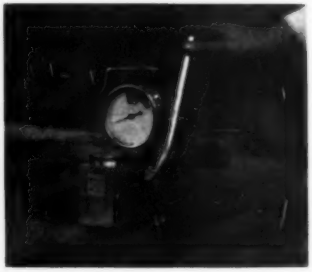
cleaned, penetrant applied, excess penetrant removed and the developer applied. As the developer dries, red indications appear at defects.

For further information circle No. 928 on literature request card on p. 32B

HARDNESS TESTER: The new King portable Brinell hardness tester, designed especially for testing nonferrous alloys, makes accurate Brinell tests from 62½ to 1000 kg. The load at which tests are to be made can be



set in the tester. When this is done, the machine will control the load, popping off automatically when the test is completed. It cannot be overloaded, and the operator cannot influence the load.

For further information circle No. 929 on literature request card on p. 32B

"LEAK-PRUF" SOLDER: Alpha Metals, Inc., has announced Tri Core Leak-Pruf acid-filled solder, a new solid flux acid-filled solder for all metals except aluminum and magne-

sium. The Leak-Pruf feature assures a solder that will not leak or drip and does not require crimping after use.

For further information circle No. 930 on literature request card on p. 32B

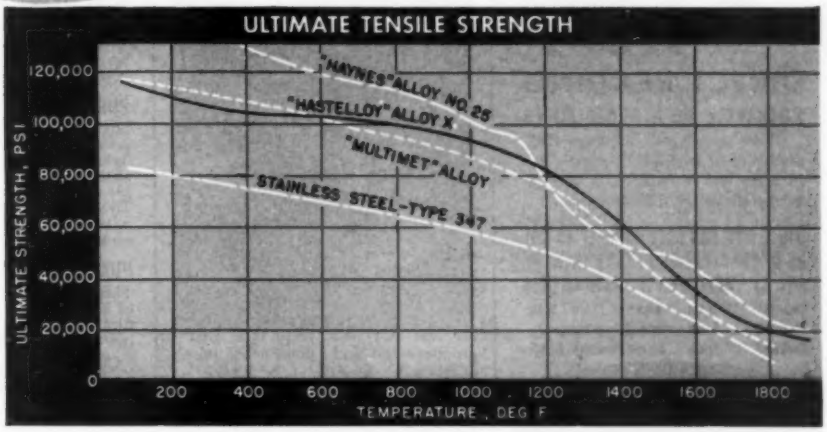
CERMETS: Kentanium, the heat resistant metal-ceramic combination of Kennametal, Inc., is now being fabri-

A New

"HAYNES" HIGH-TEMPERATURE ALLOY

HASTELLOY
Trade-Mark
Alloy X

High Strength at Elevated Temperatures
Excellent Oxidation Resistance
Low Strategic Alloy Content
Excellent Formability
Good Casting Characteristics



The excellent high-temperature properties of HASTELLOY alloy X—a new material that contains iron, nickel, chromium, and molybdenum—make this alloy a good choice for aircraft sheet-metal parts, such as cabin heaters, tail cones, and collector rings. It is also being tested for aircraft nozzle vanes, both precision-investment-cast and fabricated from sheet. In addition, it is designed for high-temperature applications in the chemical, petroleum, metal-producing, and heat-treating industries.

HASTELLOY alloy X has a relatively low content of strategic metals. Tests made so far indicate that alloy X has high-temperature properties comparable to those of other alloys containing a higher percentage of strategic metals (see graph).

The new alloy is available as sheet, plate, bars, wire, and precision-investment castings. For additional properties data, write to our General Offices in Kokomo, Indiana, for a copy of the new booklet "HASTELLOY Alloy X."

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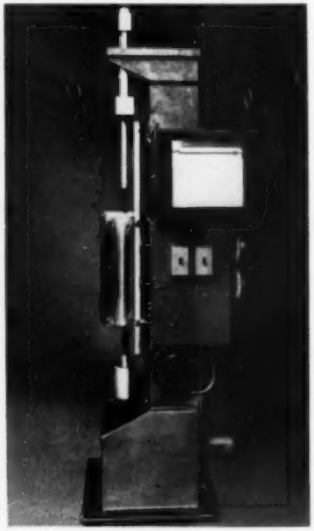
cated into parts and shapes for gas turbines. Turbine blades of Kentanium compositions withstand continuous temperature cycling between 1800° F. and room temperature.

For further information circle No. 931 on literature request card on p. 32B

CREEP RECORDERS: A recorder for Baldwin lever-type creep machines is produced by Baldwin-Lima-Hamilton Corp. Creep of 0.020 in.



produces full scale movement, 10-in., of the pen across the chart. Driven at ¼-in. per hr., a 150-ft. chart roll gives a 300-day record.

For further information circle No. 932 on literature request card on p. 32B

SPOOLED ALUMINUM WIRE: Spooled aluminum wire for welding of aluminum is manufactured by Weldwire Co., Inc. Aluminum alloy wires are triple-cleaned and precision layer-level wound on 10-lb. spools. Surface cleanliness guarantees weld

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All of these pure metals are available in research quantities. Project your product development plans with Pure Metals from Foote. Write for further information.

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FIRST *in research and development of the "lesser known elements."*

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Because the coating material is electrostatically atomized (no compressed air used) and electrostatically deposited, costly overspray is eliminated with the No. 2 Process.

In most installations, efficiency is in the high nineties, and in some instances, efficiency exceeds 99%. On most production lines, the No. 2 Process will produce 25% to 75% more pieces per gallon than any other spray finishing system. Efficiency is even greater when compared to conventional hand spray methods.

We will welcome the opportunity of telling you more about the Ransburg No. 2 Process, and what it can do for you in your own finishing department. Write or call.

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TWO MINUTE CARBON DETERMINATOR

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THREE MINUTE SULFUR DETERMINATOR

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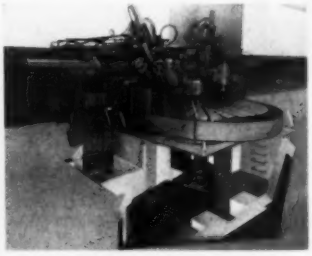
HARRY W. DIETERT COMPANY
9330 ROSELAWN • DETROIT 4, MICH.

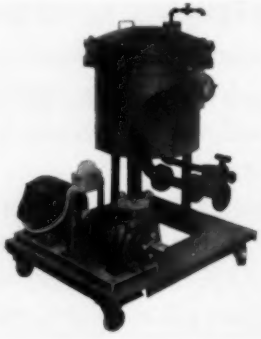
metal of sound quality, and precision spooling insures uninterrupted wire feed through welding apparatus.
For further information circle No. 933 on literature request card on p. 32B

PRECISION GRINDER: The Frauenthal grinder is a precision machine tool for large external, internal and surface grinding, as well as light boring and turning. Having table diam-



eters up to 140 in., these machines have ground to a tolerance of 0.0002 in. on diameters and parallelism of faces.
For further information circle No. 934 on literature request card on p. 32B

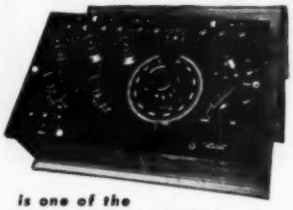
FILTER: The Sparkler Mfg. Model 818 filter is Neoprene-lined with composition plates for both acid and alkaline plating solutions. Having a capacity of 800 gal. per hr., the model



requires a floor space of 30 by 42 in. Other models are designed for filtration of oils and coolants.
For further information circle No. 935 on literature request card on p. 32B

COPPER ALLOY: Tellurium copper alloy with machinability reported to approach that of free cutting brass and with electrical conductivity 90% that of pure copper is available from Chase Brass & Copper Co. The alloy may be extensively hot worked, since addition of tellurium does not adversely affect the hot working properties, and also may be severely cold

Precise
TEMPERATURE MEASUREMENT



is one of the many applications of the
TYPE B HIGH PRECISION POTENTIOMETER

...a general purpose potentiometer with a number of notable refinements, suiting it particularly to thermocouple work. Distinctive features include:

- Three ranges —0 to 16 millivolts, 0 to 160 millivolts and 0 to 1.6 volts.
- Three reading dials—effective scale length of approximately 175 feet for each range.
- Subpanel switch and slidewire construction for protection of contacts from dust and corrosive fumes.
- Special provisions to minimize parasitic thermal emf's—including automatic compensation of slidewire thermals and gold contacts in galvanometer key.
- Exceptional convenience in reading and adjustment.
- Solid and substantial construction for many years of trouble-free service.

This standard laboratory potentiometer is also well suited for meter calibration, for checking portable potentiometers, and for other critical measurements of D.C. potentials requiring exceptionally high accuracy.

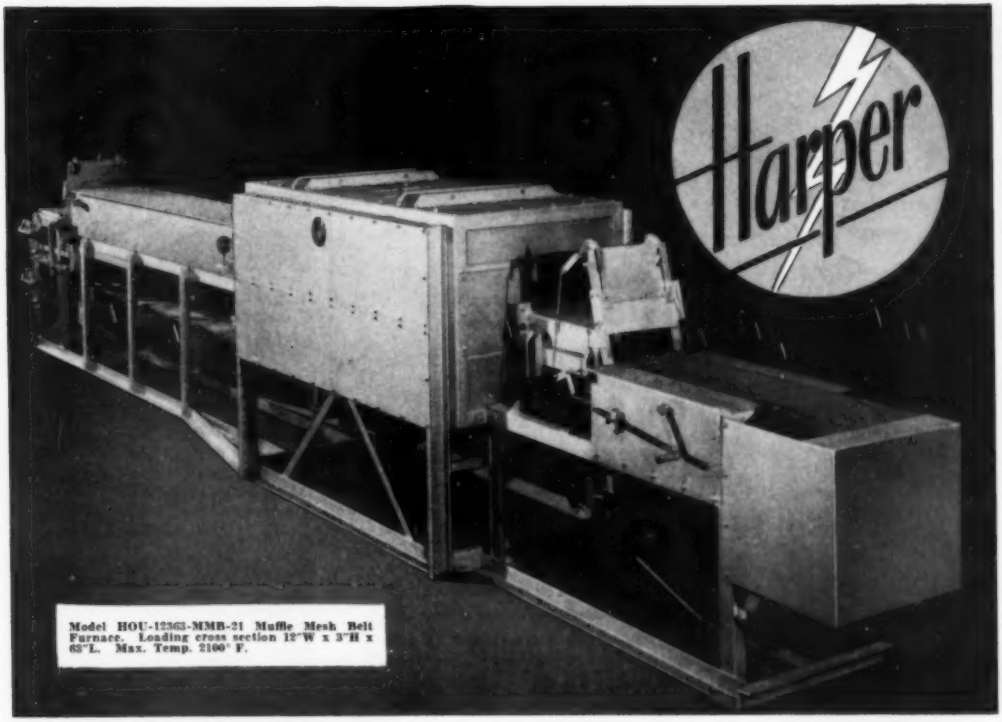
Described in Bulletin 270

SPOTLIGHT GALVANOMETER FOR SHOP AND LABORATORY WORK

- Sturdy, short period
- Sensitive (up to 1.5 μV per mm.)
- Multiple-reflection optical system
- 100-Millimeter scale
- For null or deflection measurements

Described in Bulletin 320

RUBICON COMPANY
Electrical Instrument Makers
3758 Ridge Avenue • Philadelphia 32, Pa.



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FOR CONTINUOUS SINTERING AND BRAZING

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A MORE UNIFORM PRODUCT—You will obtain a more uniformly heat treated product with Harper Electric Mesh Belt Furnaces. Materials are conveyed smoothly and continuously on a sturdy mesh belt, through clean, unvarying electric heat, evenly distributed throughout the heating chamber, under accurately controlled atmospheric conditions.

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Harper Electric Mesh Belt Furnaces are available in several sizes to meet individual production requirements. Write, telling us of your requirements, and we will be glad to recommend and quote on equipment to your satisfaction.

HARPER ELECTRIC FURNACE CORPORATION

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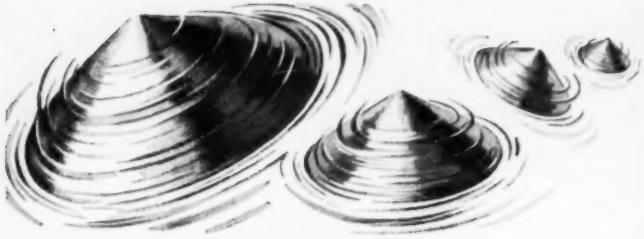

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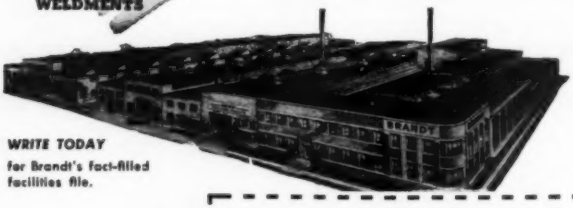

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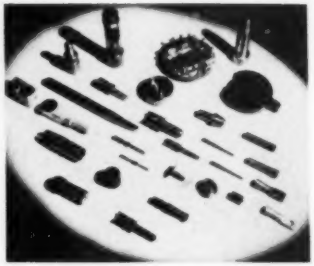
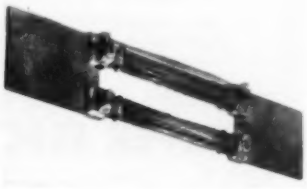


worked although less ductile at room temperature than pure copper. Tellurium copper is supplied in hard or half hard temper rods and bars.
For further information circle No. 936 on literature request card on p. 32B

DIFFRACTION UNIT: A compact, new X-ray diffraction unit, the XRD-4, was recently announced by the X-Ray Dept., General Electric Co. The unit, designed for film techniques only, requires about half the floor space taken

by the all-purpose unit. The unit has a self-contained water cooler which eliminates plumbing and obviates condensation, mineral and sediment deposits and scale obstructions.
For further information circle No. 937 on literature request card on p. 32B

WELDING: Erico Products, Inc., reports the "Cadweld" process permits welding of large conductors which give consistent performance under extremely heavy currents and maintain 100% electrical efficiency under heat and corrosive atmospheres. One such application is a plating-rack jumper, a lead from power bus to plating tank, which carries up to 3 million circular



Cowles AM

A non-etching type aluminum cleaner for use in soak tank cleaning. It was specifically designed to remove drawing, stamping, spinning compounds, rolling oils, marking inks, crayon marks and shop dirt from common aluminum alloys prior to spot welding, anodizing or other finishing operations.

for better aluminum cleaning and deoxidizing

Cowles DO

A powdered acid type deoxidizer designed for efficient removal of the oxide film from aluminum prior to spot welding, anodizing or chromate finishing. It inhibits rapid reoxidation. DO solutions dissolve primary film rapidly, then reoxidize the metal surface slowly and uniformly with an air-stable oxide film without leaving smut residues

Write for Technical Data Sheets on Cowles AM and DO Cleaners Prompt Shipments from Convenient Warehouse Stock

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METAL CLEANER DEPARTMENT
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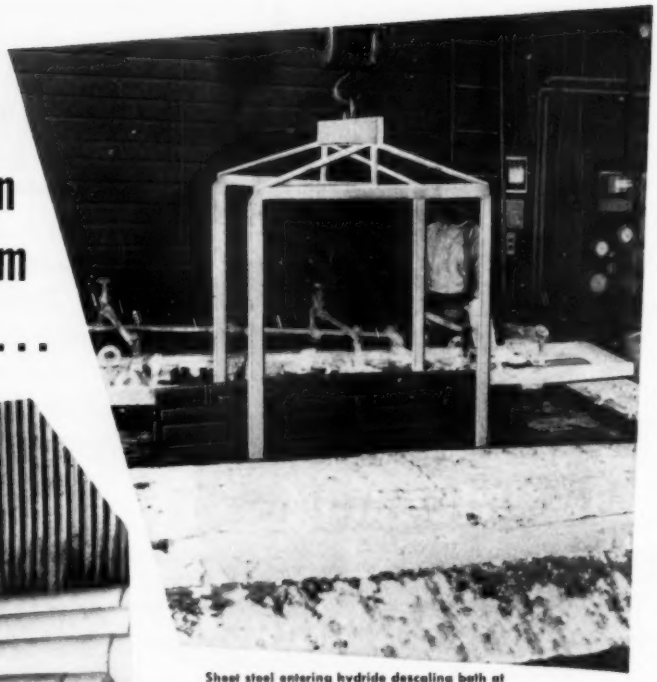
To obtain low-cost hydrogen for sodium hydride descaling . . .



Sheet steel entering hydride descaling bath at Universal Cyclops Company, Bridgeville, Pa.

Cylinders take up minimum working space.

Universal Cyclops dissociates Du Pont "National"* ANHYDROUS AMMONIA IN CYLINDERS 99.99% Ammonia

In descaling sheet steel at Universal Cyclops, hydrogen is introduced into burners at the hydride descaling bath where it combines with sodium to produce sodium hydride. Universal Cyclops uses Du Pont "National" Anhydrous Ammonia as a dependable source of hydrogen—one 150-lb. cylinder dissociated yields the equivalent of 25½ cylinders of hydrogen.

The high purity of Du Pont "National"—99.99% Ammonia—means fewer shutdowns for removing oil deposits from catalysts used in dissociating. And the cylinders are convenient to handle . . . take up little working and storage space.

Du Pont "National" Anhydrous Ammonia is always uniform, always dependable, always dry—with a moisture content of less than 50 parts per million. It is immediately available from distributors and stock points shown in the list on the opposite page. E. I. du Pont de Nemours & Co. (Inc.), Polychemicals Dept., Wilmington 98, Delaware.

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Washington ..... Henry M. Sweeny Co., Inc.
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Jacksonville ..... Apperson Chemical Company
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GEORGIA
Atlanta ..... Southern States Chemical Co.
Savannah ..... F. H. Ross & Co.
IDAHO
Boise ..... Van Waters & Rogers, Inc.
INDIANA
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IOWA
Cedar Rapids ..... Cherry-Burrell Corp.
Sioux City ..... Kennedy & Parsons Co.
KANSAS
Wichita ..... Barada & Page, Inc.
KENTUCKY
Louisville ..... Louisville Mill Supply
LOUISIANA
New Orleans ..... Whitman-Holloway-Olivier
MARYLAND
Baltimore ..... Leidy Chemicals Corp.
MASSACHUSETTS
Boston ..... A. E. Borden Co. Inc.
Fall River ..... Borden & Remington Co.
Holyoke ..... Eastern Chemicals, Inc.
MICHIGAN
Detroit ..... Davis Supply Co.
Flint ..... Davis Supply Co.
MINNESOTA
St. Paul ..... Cherry-Burrell Corp.
MISSOURI
Kansas City ..... Barada & Page, Inc.
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Newark ..... National Oil & Supply Co.
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mils. Another is an electric furnace lead 1.75 million circular mils to ½ by 3 lug.

For further information circle No. 938 on literature request card on p. 32B

MICROHARDNESS TESTER: The Zeiss Hanemann microhardness tester, a 30× apochromatic objective with a Vickers diamond pyramid built into the front element, offers a high degree of responsiveness and reliability in fixing the point of impact. The load

scale is observed through the microscope. Measurements may be carried out immediately after the impression with no change in set-up or adjustments required. The lens fits the Neophot metallograph.

For further information circle No. 939 on literature request card on p. 32B

SPECTROMETER: Baird Associates direct-reading spectrometer is a fully automatic control-analyzer for melt

shop production, which handles up to 30 elements in less than a minute.

For further information circle No. 940 on literature request card on p. 32B

CHROME CARBIDE: Preliminary applications of grade 608 chrome carbide, the first of a new Series-600 cemented chrome carbides, have been reported by the Carboloy Dept., Gen-

What do you know about the *Moly-sulfide* LUBRICANT?

A LITTLE DOES A LOT

You may have heard about a highly successful solid-film lubricant which is giving remarkable results in the shop and in the field.

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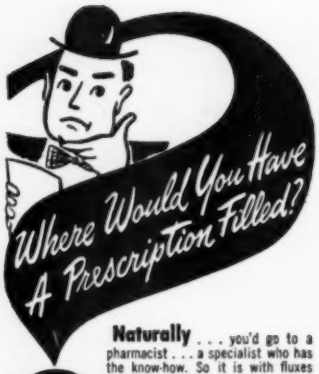

Naturally . . . you'd go to a pharmacist . . . a specialist who has the know-how. So it is with fluxes . . . Special Chemicals engineers have been specializing in the formulation and production of hard soldering and brazing fluxes for more than 20 years. That's why you can depend on KWIKFLUX for better metal joining of ferrous and non-ferrous metals at lower cost. Works perfectly with both low and high melting point hard solders and all types of heat applications . . . direct, indirect and induction heating.

*T.M. Reg. Pat. Nos. 2,174,551 2,196,853 2,452,995

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NEW! ANTI-CRYSTALLANT HARD SOLDERING and BRAZING FLUX

Only KWIKFLUX Has These EXCLUSIVE Features:

- **SUPER WETTING ACTION** speeds work, eliminates lumping or pitting of solder. **Cleans, protects** and **flows** into tightest fitting joints.
- **MIRACLE FLOWING SPEED** — Dependable KWIKFLUX resists evaporation, flows faster, works cleaner and eliminates skip spots. Melts at 780°F and remains stable up to 1800°F and higher.
- **DOUBLE PENETRATION POWER** patented phosphate formula gives KWIKFLUX better bite action and deeper penetration.
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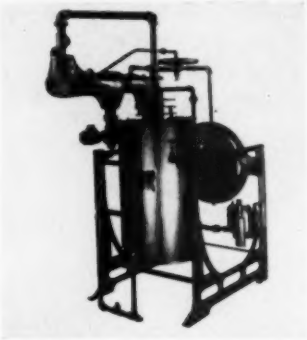
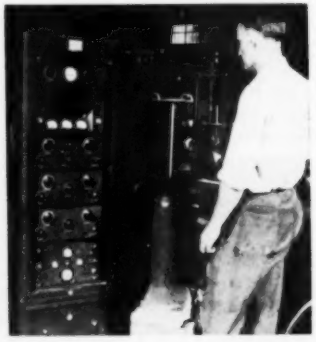
eral Electric Co. The alloy is 83% chrome carbide, 2% tungsten carbide and 15% nickel. The material is now available in limited quantities in a variety of shapes for test applications. **For further information circle No. 941 on literature request card on p. 32B**

OIL-GAS GENERATOR: The Vapofier Corp. generator converts a light fuel oil into a gas that can be burned or controlled in the same manner as



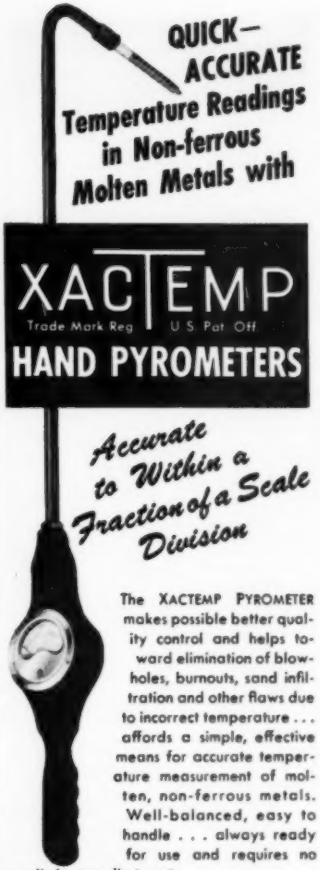
natural or manufactured gas. The equipment can be used as a standby source or as the primary source of fuel in heat processing.
For further information circle No. 942 on literature request card on p. 32B

MAGNETIC FLAW DETECTER: Equipment of the Magnetic Analysis Corp. is designed for magnetic inspec-



tion of steel bars and tubing in the production line during the regular processing of the material.
For further information circle No. 943 on literature request card on p. 32B

FILM FIXER: A liquid fixer chemical as stainless as powdered fixers has been announced by the X-Ray Dept., General Electric Co. The fixer is reported to be considerably faster and easier to mix than powdered fixers. After 200 films, where powdered fixers take 6¼ min. to clear and 12½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Catalog No. MM701 $62.50
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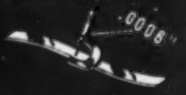
One of the things you'll see spotlighted at Sandvik's booth is Sandvik's Super-Precision . . . strip steel, cold rolled to .0006" (6/10,000ths of an inch)!



55-84

TOOL STEELS

PRK-33 Air Hardening, Non-Deforming Cobalt, High Carbon, High Chrome. For high production blanking, forming, drawing, trimming and shearing.

NEOR The Original Oil Hardening, Non-Deforming High Carbon, High Chrome. Recognized as the ideal lamination die steel. Also suitable for other long-run dies.

MINEOR 5% Chrome, Air Hardening, Non-Deforming. Has many desirable features of more expensive air hardening steels. Tough at high hardness.

OHT Oil Hardening, Non-Deforming. Excellent machinability, minimum distortion, good resistance to wear. An economical steel for short-run dies.

"MT6" The Standard "M2 Type", High Speed Steel. Designed for a superior tool and at the same time save critical alloys.

A Darwin tool steel, used in the manner recommended by our engineers, is the positive answer to tool steel troubles. Darwin carries a complete range of tool steels, each best in its class, each capable of performing an outstanding job. Check with us before you specify tool steels—we know it will be profitable for you.

Furnished in bar stock, billet, forging, sand casting. Drill rod, flat ground stock, tool bits. Bulletin on Request.

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highest grade tool steels

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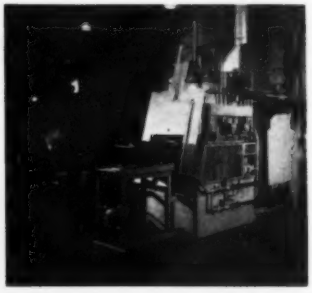
to fix completely, this liquid fixer takes only 4½ min. to clear and 9 to fix.
For further information circle No. 944 on literature request card on p. 32B

ROUGHING TOOL: A new clamp-on turning tool, "Hefti-Cut", was recently announced by the DoAll Co. Heavy cuts, which reduce turning time in getting down to the desired diameter, are possible. The tool consists of an alloy steel shank which holds carbide blanks. The manufacturer reports a new method of holding the blanks which provides rigidity and permits use of 60% of the blank before discard.

For further information circle No. 945 on literature request card on p. 32B

CARBONITRIDING FURNACE: A new gas-fired vertical radiant tube carbonitriding furnace by Lindberg features lightweight vertical radiant tubes which may be removed and replaced in a few minutes. The furnace is a packaged unit with quench system built in and automatic cycle control.



For further information circle No. 946 on literature request card on p. 32B

WIRE BRUSHES: Osborn Manufacturing Co. has available wire wheel brushes which mount directly on a stand grinder for removal of feather edges left after machining. The flexibility of the brush permits it to blend

"Increased production as much as 30% per man hour"

...says Aluminum Industries, Inc.

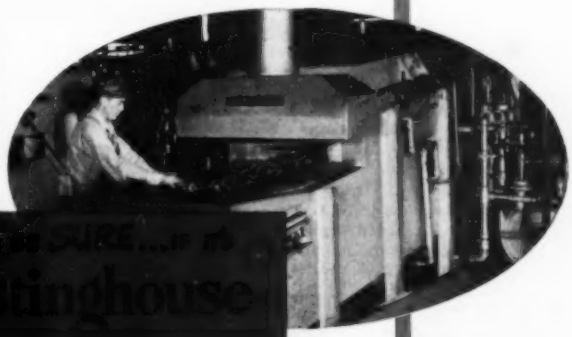
"Since the installation of our new Westinghouse furnace, our maintenance costs have been greatly reduced—with an increase in production of approximately 30% per man-hour. Rejects have been practically nil . . . greatly reducing the factors of bent pieces and production losses that were common with the old-type furnace."

Aluminum Industries, Inc., Cincinnati, Ohio, and Westinghouse engineers co-operated in designing this *gas-fired,* conveyor-type furnace to exact Aluminum Industries requirements. While the furnace was designed, manufactured, and installed primarily for bright-annealing automotive engine valves, it has also been used to bright-harden other company products—proof of its versatility in a specialized industry.

Gas-fired or electric, there's a Westinghouse furnace engineered to meet every heat-treating need. A wide selection of standard units are available, or special designs can be prepared to meet particular requirements. Get the facts from your nearby Westinghouse representative. Ask for the 40-page book B-5459, or write Westinghouse Electric Corporation, Industrial Heating Department, Meadville, Pennsylvania.

J-10384-B

IF YOUR PRODUCT CALLS FOR HEAT-TREATING...IT CALLS FOR A WESTINGHOUSE FURNACE ...GAS OR ELECTRIC

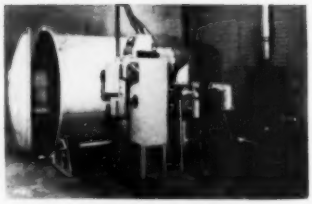


Westinghouse

HEAT-TREATING FURNACES

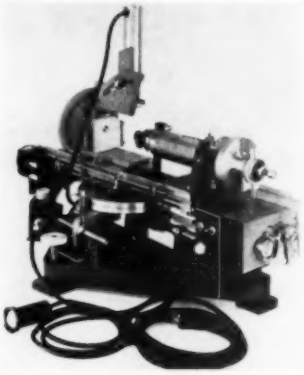
minute surface roughness, thereby removing abrasive action on the belt. **For further information circle No. 947 on literature request card on p. 32B**

RADIOGRAPH MAGNIFYER: The new Picker X-Ray Corp. Lewin Magnifyer, a clamp-on spotlight with a 5-in. diameter magnifying lens attached, enables the radiographer to examine high-density areas of radiographs. The device attaches to any surface or may be permanently installed.
For further information circle No. 948 on literature request card on p. 32B



VACUUM COATING TANK: National Research Corp. is introducing a new line of high vacuum equipment. A large tank coater, 5½ ft. in diameter is now offered. A variety of pumping systems is available. For maximum production a unit of two 16-in. diffusion pumps, two 6-in. booster pumps and a 200 cfm. mechanical roughing pump is recommended. The tank can be pumped to coating pressures in less than 5 min. under ideal conditions.
For further information circle No. 949 on literature request card on p. 32B

GEIGER COUNTER: The North American Philips Co. now has available a Geiger-counter attachment for Weissenberg goniometers for diffrac-



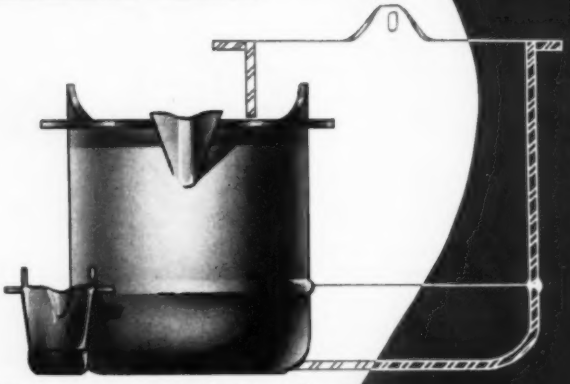
tion use. The instrument is used in conjunction with the counting circuits and recorder employed with the Philips X-ray spectrometer. The conversion of the Weissenberg entails only attaching of a Geiger tube, angular position mounts and a special mechanism for oscillating the crystal.
For further information circle No. 950 on literature request card on p. 32B

BLACK FINISH: A new jet black finish for iron and steel, "Parco Black", is reported by Parker Rust Proof Co. The product is used in water solution at low temperatures.

Parts are immersed for 15 to 30 min. in the noncaustic processing bath. After rinsing, drying and oiling or waxing, the finish is ready for service.
For further information circle No. 951 on literature request card on p. 32B

CHILLING UNIT: A modification of the chilling chamber of Sub-Zero industrial chilling machines to obtain complete circulation of the convection fluid in the chamber six times per minute, has been announced by Sub-

Magnesium Melting the
**AMERA-MAG Way!*



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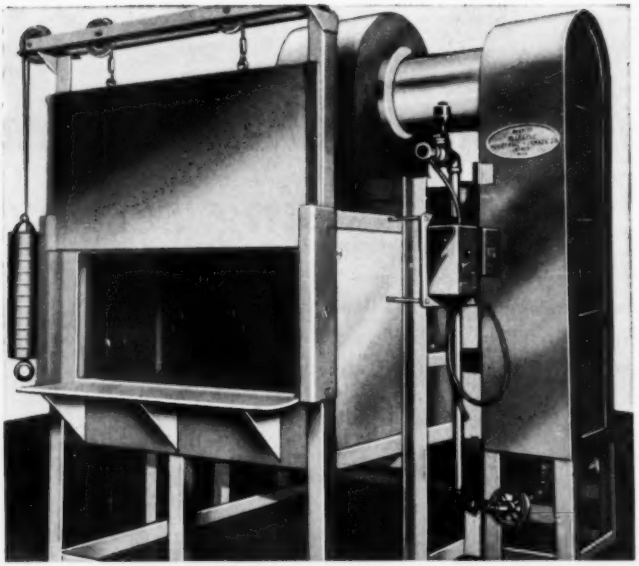

Batch type furnace for the heat treating of aluminum alloys—consists of atmosphere type burner mounted on the lower end of the duct which is for recirculating the air back into the furnace. Garden City high temperature fan is standard equipment for recirculating the heated air. This method of heating holds temperature with little or no variation. Mounting the burner in the duct, eliminates the necessity of an extra heating unit. . . .Send us your heat treating problems . . . our engineers will make a proposal without obligation.

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TECHNICAL PERSONNEL OFFICE

CARBIDE and CARBON CHEMICALS COMPANY

a division of

UNION CARBIDE and CARBON CORPORATION

POST OFFICE BOX P, OAK RIDGE, TENN.

Zero Products. The modification is available on special size units and standard models.
For further information circle No. 952 on literature request card on p. 32B

STUD WELDER: Graham Manufacturing Corp. has added a new portable stud welder to its line. The welder requires only an electrical connection for operation. Electric power in 110, 220, or 440 volts a-c. can be used.

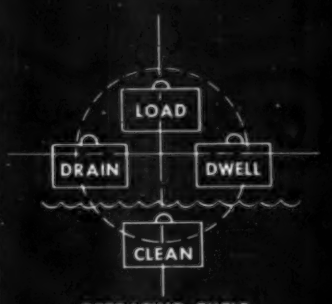
Wattage pull is low. Construction of the stud holder provides a wide variety of stud sizes and shapes, including hooks, and headed studs in sizes up to ½ in. diameter.
For further information circle No. 953 on literature request card on p. 32B

ULTRASONIC TESTER: Ultrasonic inspection for flaws in a wide variety of materials can be accomplished with the Reflectoscope manufactured by

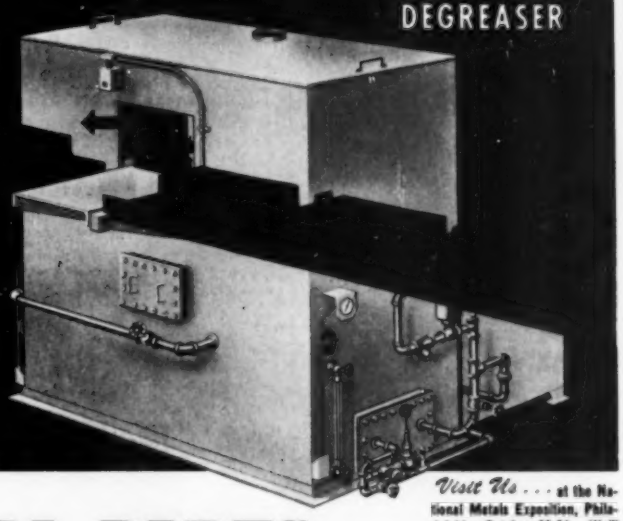
Sperry Products, Inc. This portable instrument permits rapid testing of inaccessible equipment and structures.
For further information circle No. 954 on literature request card on p. 32B

D-C CURRENT SUPPLY: An electronic constant current supply which provides a steady d-c. source from an a-c. line, has been introduced by Weston Electrical Instrument Corp. Designed primarily for use with potentiometer indicators and controllers where automatic standardization is

totally-enclosed **GYRO** DEGREASER



OPERATING CYCLE



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degreased automatically—at lower cost!

Designed for cleaning small parts, both ferrous and non-ferrous, in basket loads, the Detrex Gyro Degreaser eliminates the need for overhead hoists and does the work of conveyorized equipment costing twice as much. It occupies a small floor space . . . yet thoroughly and economically cleans up to 40 work loads per hour with a capacity up to 50 pounds per basket. The Gyro Degreaser is automatic—your operator's time is free for loading and unloading.

Work baskets are loaded through a door in the front of the machine onto a wheel-type rotary conveyor. Each basket passes through four cycles as illustrated above: (1) Load and unload; (2) Dwell; (3) Solvent cleaning; (4) Drain. Because the baskets remain in each position for a controllable time, the work is cleaned uniformly and solvent vapors are retained in the machine during unloading.

The Gyro affords ideal working conditions and maximum solvent conservation since it will operate only with the loading door closed . . . all operations are totally enclosed and cross drafts are completely eliminated. When the loading door is opened, the machine is vented by natural draft away from the operator.

Gyro degreasers are manufactured by Detrex in standard, steam-heated models for spray or immersion cleaning. The cycle time is variable to suit the requirements of the work.

Detrex, the originator of modern solvent degreasing, also builds many other types of standard and special purpose degreasers. An experienced field engineer will survey your needs and make recommendations without charge or obligation. For information write today to **Detrex Corporation, Box 501, Detroit 32, Michigan.**

D-2

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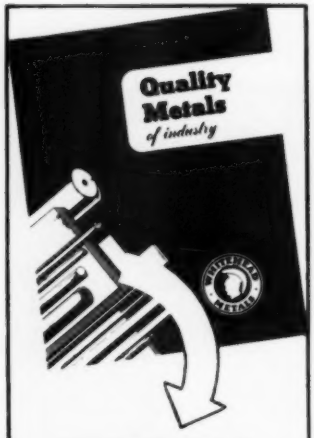

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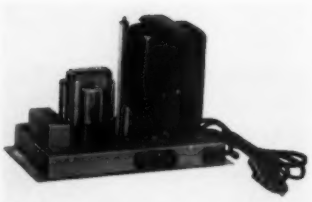
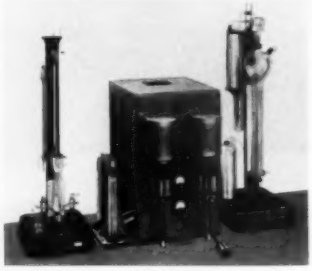


not feasible or where batteries are not desirable, it can also be used with resistance thermometers, strain gages, or other devices requiring constant d-c. current. Operating from 115-volt supply, the standard unit has a 10-ma. output at 1.4 volts d-c.

For further information circle No. 955 on literature request card on p. 32B

INDUCTION COMBUSTION FURNACE: Harshaw Scientific's new Leco IH-15 induction furnace combines a single-tube carbon furnace and a single-tube sulphur furnace with one power source. Power is directed to



one combustion tube at a time, allowing one sample to be burned while the other is weighed and loaded. The unit can be equipped to analyze sulphur or carbon from both sides.

For further information circle No. 956 on literature request card on p. 32B

CUT-OFF WHEEL: The Allison Co. wheel for cutting refractory brick has an entirely new combination blotter and arbor hole bushing to provide simple, trouble-free mounting, with extra protection to both the wheel and the spindle.

For further information circle No. 957 on literature request card on p. 32B

MICROPHOTOMETER: National Spectrographic Sales Corp. has announced a new microphotometer, the "Spec-Reader", designed for qualita-

tive, semi-quantitative and high-accuracy work. The large viewing screen permits easy viewing in a normally lighted room.

For further information circle No. 958 on literature request card on p. 32B

WELDING HEATERS: An electric tubular heater for welding steel pipe and plate has been announced by the Edwin L. Wiegand Co. For straight-line welds, heaters are bolted to tack-welded studs about 6 in. from the weld line. Special heater shapes are used

to fit the heat to other weld contours. Heater elements are triangular in cross section, one flat side being in contact with the work.

For further information circle No. 959 on literature request card on p. 32B

HEAT TREATING FURNACE: The Sentry Co. Model Y electric furnace is conveniently adaptable to the production hardening of molybdenum high speed steels, an operation of special interest in days when molybdenum steels must be substituted for tungsten types.

For further information circle No. 960 on literature request card on p. 32B

SALT BATHS: The A. F. Holden Co. has announced a new series of six neutral salt baths with additives. These baths do not require hourly

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THE TURCO MAN... or more specifically the *Turco chemists, technicians and service engineers* who collectively are the "Turco man"... will be on hand at the Metal Show. Talk to the Turco man about metal inspection, cleaning, phosphating and other surface-active chemistry applications in your processes. He can supply well-researched, experience-tested answers.

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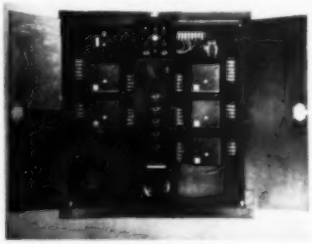
rectification to maintain the bath at full strength. According to the manufacturer, the new formulations result in less dragout and extended electrical life.

For further information circle No. 961 on literature request card on p. 32B

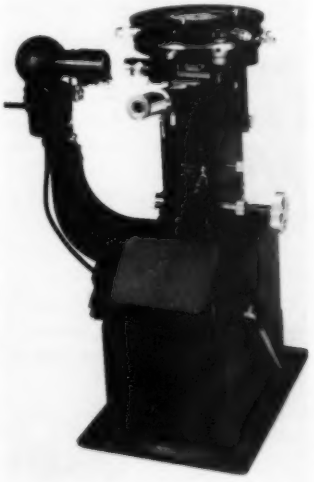
COMBUSTION SAFETY SYSTEM: Centralized combustion safety equipment for 2 to 16 burners can be accomplished with the new "Protect-O-Glo" system recently introduced by Minneapolis-Honeywell Regulator Co.



Individual flame-detecting relays for each burner are housed in a single cabinet. Detector and relay circuits shut down fuel supply in the event of flame failure at the burner.

For further information circle No. 962 on literature request card on p. 32B

PHASE CONTRAST METALLOGRAPH: The compact and versatile Reichert universal camera microscope can now be supplied with an accessory permitting the examination of metals in phase contrast. This instrument is available through William J. Hacker and Co., Inc.



For further information circle No. 963 on literature request card on p. 32B

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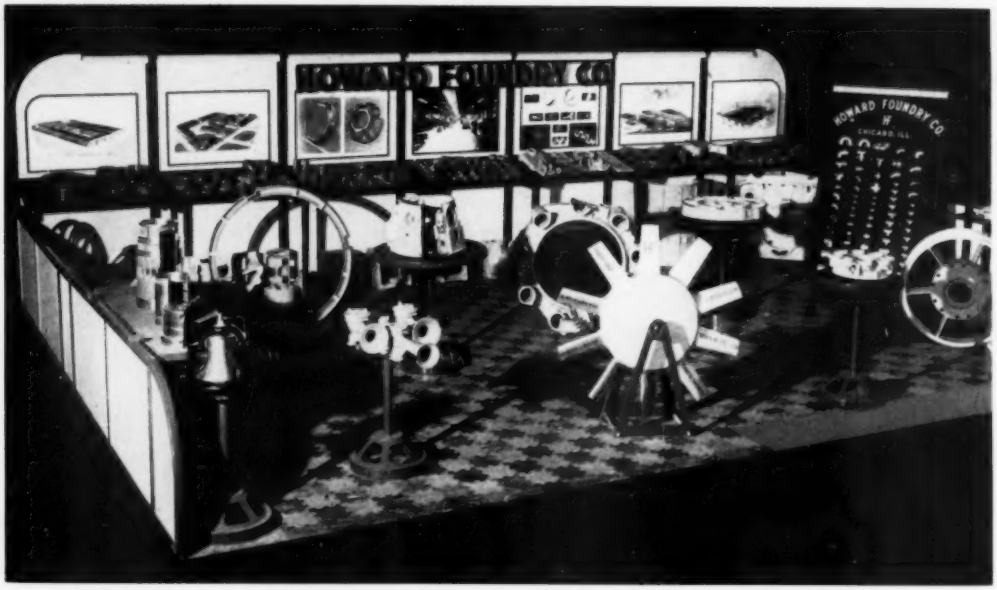

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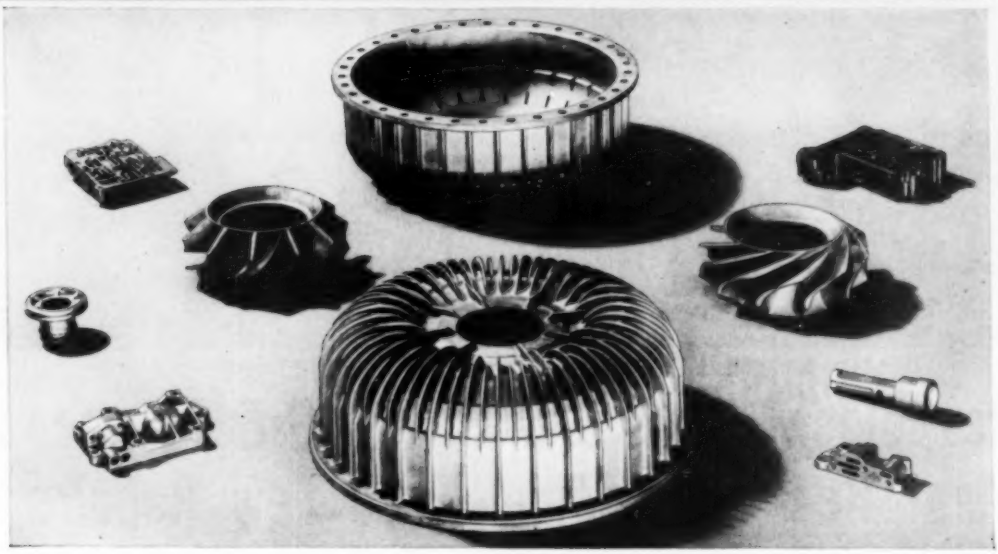

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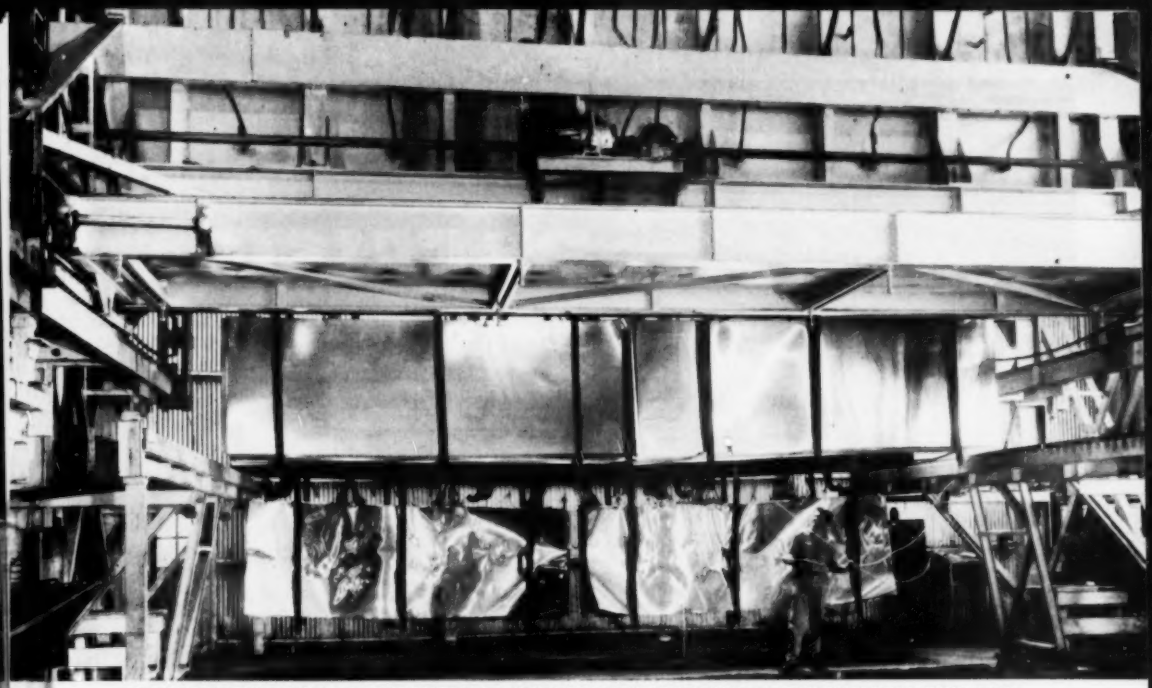

ELEVATOR FURNACE NEARS 10 YEARS SERVICE OF CONSISTENT, ACCURATE TREATMENT OF HIGH-QUALITY ALLOY SHEET.

Reynolds Metals Co. Says "G-E Furnaces Meet Heavy Schedule, Need Few Repairs"

Their Listerhill, Alabama, plant is now operating at full capacity to meet the ever-increasing demand for aluminum. And to meet this high production schedule, Reynolds depends on many types of G-E electric furnaces for annealing, aging and solution heat-treating.

MR. M. A. J. PHILLIPS, Reynolds Vice-president, says, "We are very pleased with the dependable service our G-E furnaces give with little downtime." One of his engineers adds, "Uniform heat distribution is very important in aluminum heat-treating, and the consistent high-quality work our G-E furnaces turn out proves the importance of properly locating heating elements and designing the circulation equipment to fit the loads."

ALUMINUM FABRICATORS, as well as prime producers like Reynolds, can profit by using G-E furnaces for their heat-treating operations.

TAKE ADVANTAGE of G-E experience in heat-treating of aluminum. Call the nearest G-E sales office for the services and recommendations of their experienced Industrial Heating Specialist on your heat-treating problem. *General Electric Company, Schenectady, N.Y.* 720-82

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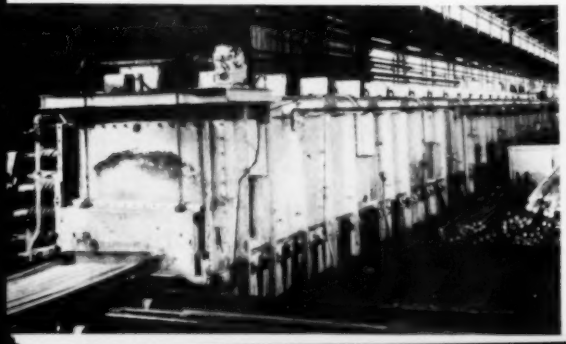
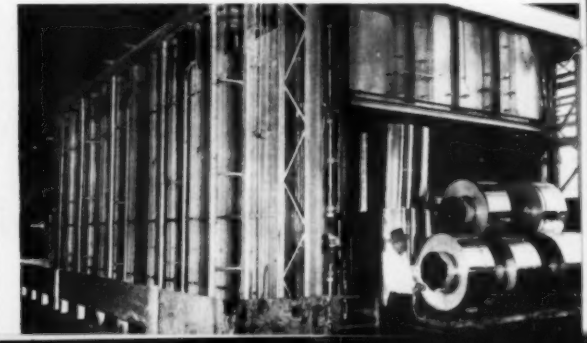
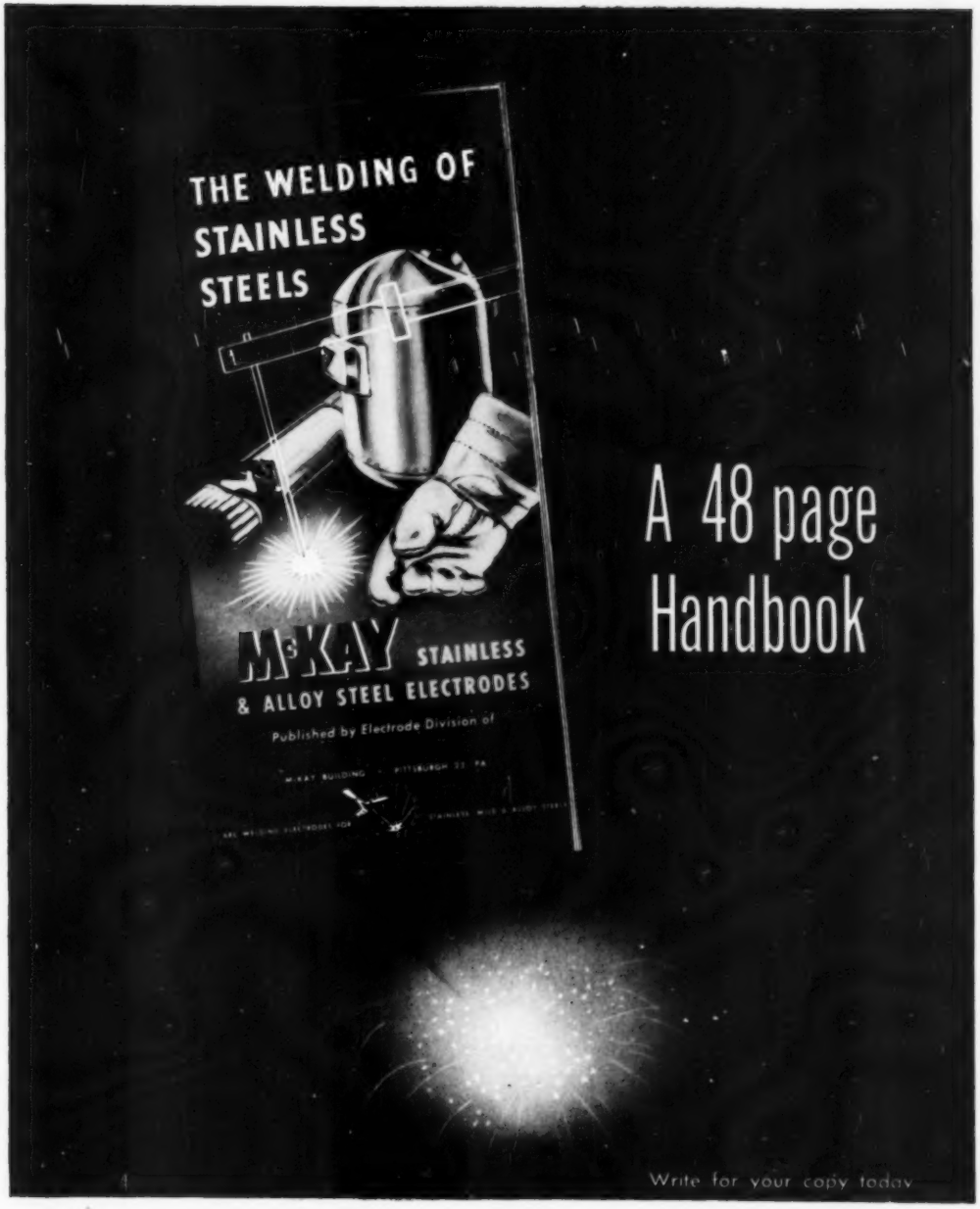


100 TONS PER CHARGE are annealed in this metal-lined truck furnace. Highest-quality stock results from uniform heating.

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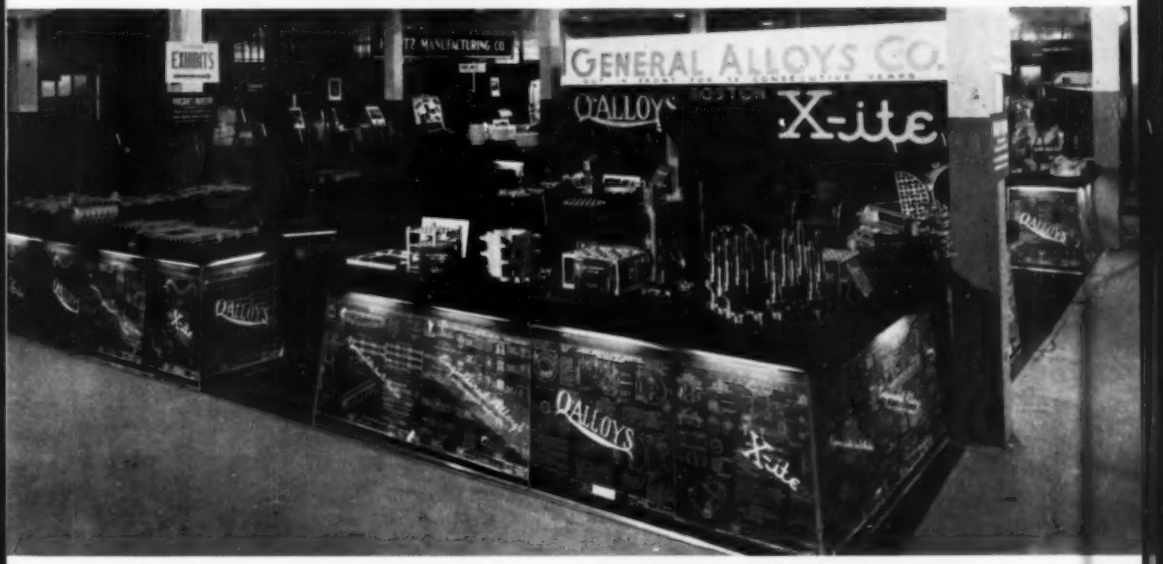

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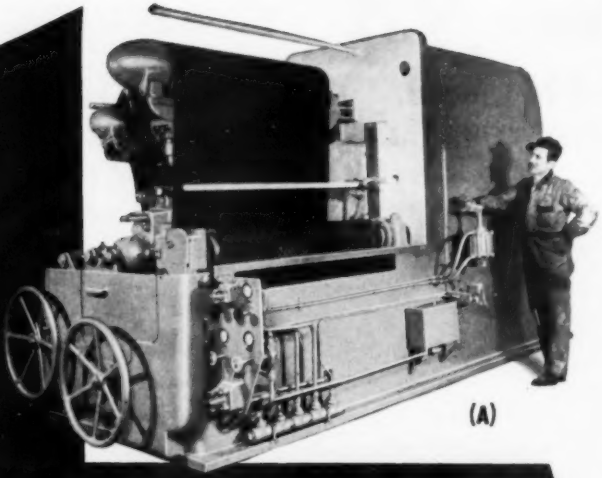
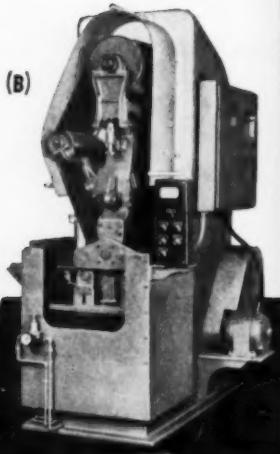
Associated Steel Mills, Inc.
1851 So. Kingshighway

THE FOOTSTEPS OF GENERAL ALLOYS MARK THE PATH OF AN INDUSTRY



(A)



(B)

IF THE STOCK IS FLAT

MICRO-POLISH

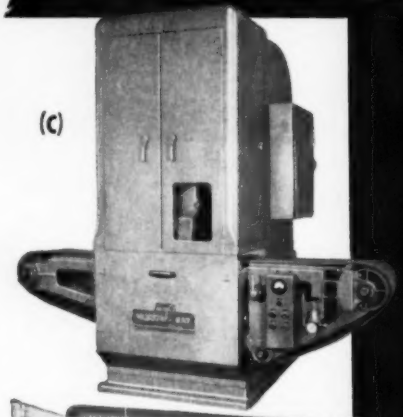
can automatically finish your job faster, better or cheaper regardless of size, shape or material.

Murray-Way, "engineered-to-the-job", Micro-Polish equipment is now being used the country over in every type of application, on every conceivable kind of material.

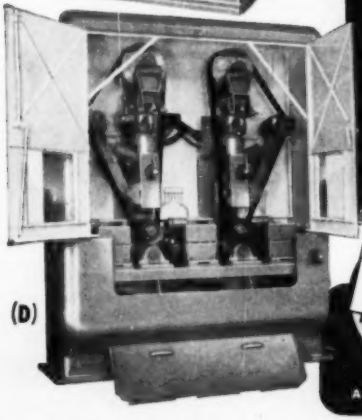
Micro-Polish is an amazingly versatile and consistently successful automatic polishing method useful on any job from the prepolishing of low grade steel sheet, to meet high quality job specifications, to the production sharpening and polishing of pruning tools.

Micro-Polish can precision finish any size, shape or length of sheet, strip or blanked stock in ferrous or non-ferrous metals, wood, fiber, plastic, rubber or leather, by wet or dry process.

The typical Micro-Polish equipment shown here demonstrates how Murray-Way engineers have adapted the process to individual job requirements.



(C)



(D)

A Micro-Polish giant used in reclamation grinding of steel strip.

B One of our smaller units used in polishing narrow bi-metal stock.

C A versatile unit using belt conveyor to polish a variety of flat stampings and forgings.

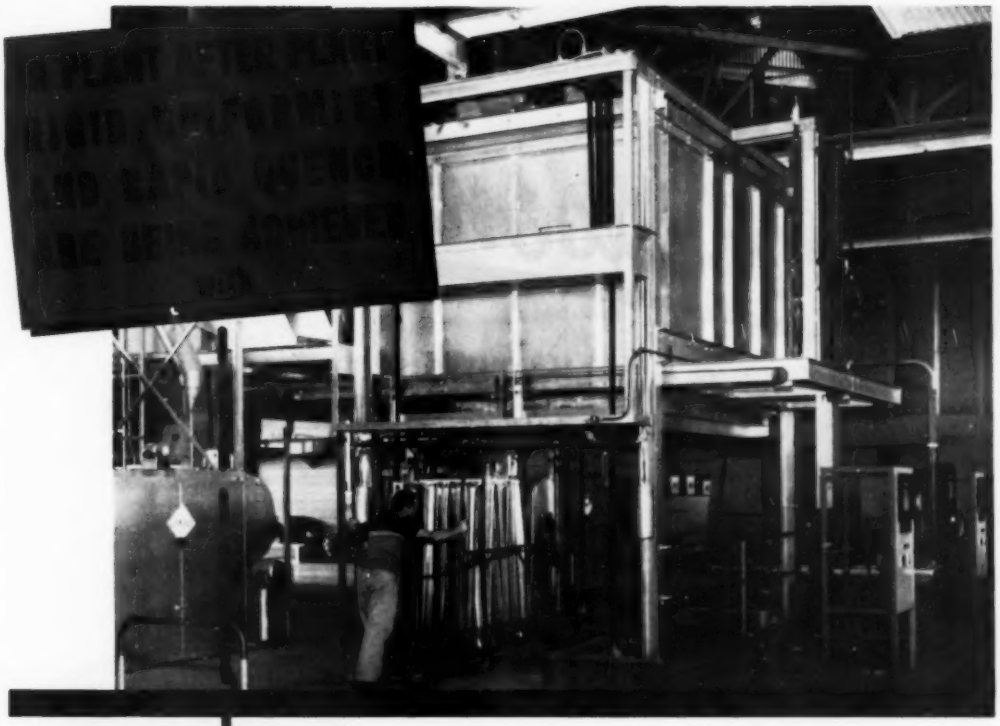
D A space saver unit for polishing flat bar stock. Two heads and two grades of belt grain accomplish the complete job without rehandling.

Murray-Way engineers will gladly show you how this time and cost saving method can improve your polishing operation.

MURRAY WAY THE MURRAY-WAY CORPORATION

POST OFFICE BOX 180 – BIRMINGHAM, MICHIGAN

AUTOMATIC POLISHING, BUFFING, GRINDING EQUIPMENT



DESPATCH Aluminum Heat Treating FURNACES

Battery of DT (Pot Type) Gas Fired Furnaces heat treating 20 MM shell cases

Battery of Despatch recirculating Furnaces for aging aluminum castings

Wherever the solution heat treating of aluminum plays a prominent part in production operations, more and more plants are turning to DESPATCH built furnaces for better uniformity, speed-of-quench and economy.

The DESPATCH bottom entry, quick-quench furnace shown, is being used in the aircraft division of a large West Coast manufacturing firm for the solution heat treating of aluminum aircraft parts. Developed by DESPATCH engineers especially to meet rigid Government schedules and airforce specifications, this furnace is one of several that have been designed, built and installed by DESPATCH for major plants throughout the country, now engaged in Defense Production.

RAPID QUENCH—Less than 10 seconds: Electrically heated, the furnace has a temperature uniformity within ±5°F., and a temperature range up to 1250°F. The time consumed from work chamber to quench pit is less than 10 seconds. Doors and elevators are interlocked and air operated. Capacity of work chamber is 600 lbs. of aluminum plus supporting steel.

DESPATCH CAN HELP YOU: Today, more than ever before, you need speed, plus uniformity and economy in all your heat processing operations, and DESPATCH can help you achieve all three. Don't let a defense contract pass you by because you haven't adequate heat treating equipment to execute it.

CALL, WRITE OR WIRE NOW! to Dept. P.

DESPATCH engineers are ready to talk things over with you . . . offer advice, or design, build and install the proper equipment for your plant. There is a resident engineer near you, who will assist with your heat treating requirements.

FIFTIETH ANNIVERSARY

DESPATCH OVEN COMPANY

6 reasons why

NIALK® TRICHLORethylene is your best buy for Fast, Low-Cost metal degreasing

1. **QUICK ACTING** . . . Cleans and dries in record time. And after rapid degreasing of surfaces, metal is warm, dry and ready for further processing.

2. **SAVES MONEY ON POWER** . . . Low boiling range means quick vaporization. Can be heated by gas, steam, or electricity. Produces a concentrated vapor at only 188°F.

3. **SAVES MONEY ON SOLVENT** . . . High vapor density means proper vapor level will be maintained in the degreasing machine. Result: more efficient cleaning with low solvent loss.

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Make sure your metal parts are 100% grease-free. NIALK TRICHLORethylene leaves them clean, warm, dry, ready for immediate electroplating, painting, enameling, lacquering, rustproofing, heat treating, pickling, inspection or assembling.

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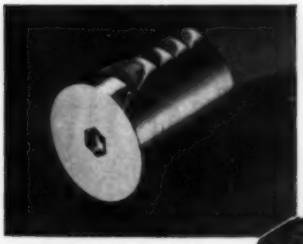
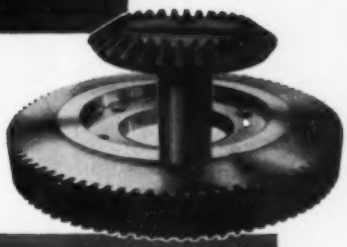
NIALK Caustic Soda • NIALK TRICHLORethylene • NIAGATHAL® (Tetrachloro Phthalic Anhydride)

Tooling or Re-tooling?

L&N FURNACES HELP TOOLS PRODUCE MORE





• Shown here are the tools and dies of some of the literally hundreds of firms that have found how to cut tool costs with Vapocarb-Hump Hardening and Homo Tempering Furnaces.

Butcher & Hart Co., Toledo, for instance, gets the uniform heating it needs to avoid distortion of the recessed head of cold-heading dies like the one shown.

The special gears of Sonoco Products Co., Hartsville, S.C., are heated with the uniformity needed to preserve their firm, true-running fit.

Towle silverware dies leave the Homocarb furnace with never a particle of scale in their intricately carved detail—need none of the stoning and other time-consuming hand finishing that would be required if scale had developed.

Heat-Treating Costs Least, Adds Most to Tool Life

A cost analysis of the simple punch and die set shown above gives a picture of the relative costs of tool-making and of heat-treating, in producing a complete tool.

The toolmakers who shaped and assembled the punch and die used machine tools worth $31,000, beginning with the cutting off of the steel and ending with the final filing. And, the tool-making time was 21 man-hours.

The heat-treater, on the other hand, used Vapocarb-Hump Hardening and Homo Tool Tempering equipment costing, complete with controls, only $5,500; and he did both jobs in 3 hours.

In other words, heat-treating represents only one-sixth of the total tool cost, yet it is largely responsible for the future performance of the tools. This is a typical example of the familiar fact that it pays to give the heat-treater precision equipment in both furnaces and controls. Whether you're tooling or re-tooling, the heat-treat's comparatively small cost can make a big difference in tool life.

A letter or call to our nearest office, or to 4927 Stenton Ave., Phila. 44, Penna., will bring complete catalog information or put you in touch with an experienced heat-treat engineer, as you wish.

CAREER OPPORTUNITIES AT L&N

Expansion program of this long-established firm has many features to attract outstanding recent graduates in engineering and science. Opportunities are in sales field engineering, product and application engineering, research, advertising, market development. Widely-respected policies assure recognition of progress and achievement. Address Personnel Manager for preliminary interview at nearest of 17 L&N offices.

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INSTRUMENTS AUTOMATIC CONTROLS • FURNACES

Ad. Ad T-680(87)

THER-MONIC

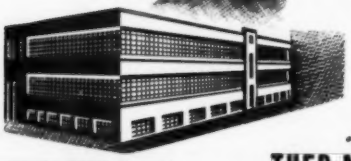
INDUCTION, DIELECTRIC & FOUNDRY CORE BAKING EQUIPMENT

King Pin HARDENING at the rate of 750 per hour!

King Pin size, 5-5/16" x 13/16". Specified hardness, 59-60 RC, and a Case of .100 to .125 obtained automatically! Operation included injection, rotation, heating, water quenching and ejection. Production rate of 750 per hour is attained by above illustrated THER-MONIC Work Table, developed especially for Chrysler Corporation. It is hooked-up to a 50 K.W. Model 2800 THER-MONIC Generator.

For more than a decade, Induction Heating Corporation has been designing and building specialized heat treating systems for the automotive and metal working industries. Water and oil pump shafts, automatic transmission and starter shafts, etc.—in fact, any component that can be processed progressively or selectively—are now being more uniformly heat treated by THER-MONIC-devised Work Tables and Generators . . . in less time and at less cost, with unskilled manpower in a minimum of space.

Enlist the services of our engineering and laboratory staffs. They will be glad to apply their know-how to your brazing, hardening, forging and annealing problems. Inquiries invited!



. . *Visit*

THER-MONIC's complete exhibit at the **NATIONAL METAL SHOW!**

Booth #1870 in the commercial museum

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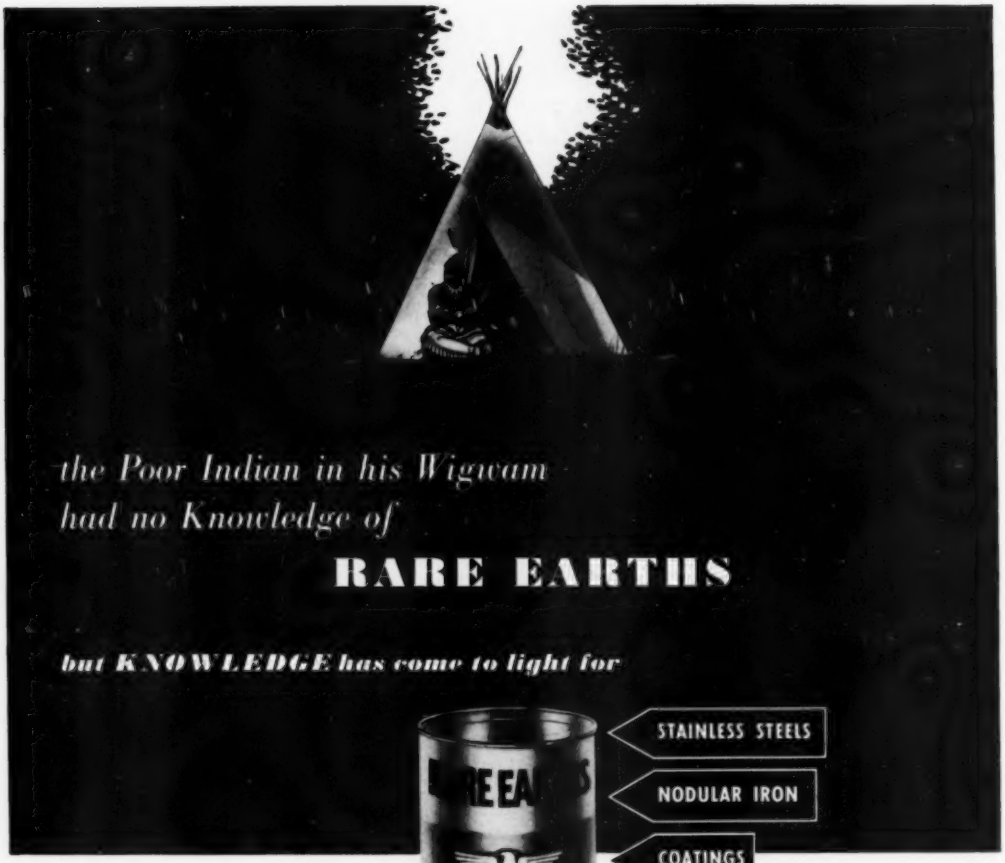
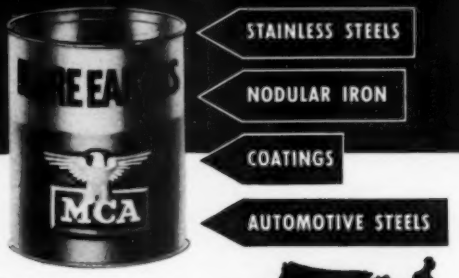


the Poor Indian in his Wigwam had no Knowledge of

RARE EARTHS

but KNOWLEDGE has come to light for



At the Metal Show in Philadelphia, you will want to learn how Rare Earths can be most useful to you. MCA representatives will be there to give any advice or help that you need.

RARE EARTHS are going into many new uses of metallurgy, ceramics, and chemistry. Now that the Molybdenum Corporation has opened up huge natural deposits within the United States, Rare Earths are in fact no longer rare.

MCA engineers have pioneered in the development of new uses. We have factual evidence of the results obtained. Production facilities are adequate for any requirement. May we have opportunity to discuss applications of possible advantage to you?

As a supplier of Molybdenum, Tungsten, Boron, and other alloying elements, the Molybdenum Corporation invites and solicits correspondence.

AMERICAN Production, American Distribution, American Control, Completely Integrated

Offices: Pittsburgh, New York, Chicago, Cleveland, Detroit, Los Angeles, San Francisco

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MCA

VACUUM VERSATILITY

for Research and Production

—RCA VACUUM UNIT

HERE IS A DEPENDABLE vacuum equipment—offering the flexibility you must have for research applications as well as the speed and convenience you need for production work.

MEETS VARIED REQUIREMENTS OF RESEARCH

Providing a ready means of performing any studies at reduced pressures or in special atmospheres, the RCA Vacuum Unit gives the research scientist a truly flexible tool to meet a variety of vacuum problems. It may also be used for "shadowing" specimens for light and electron microscopy.

APPLIES COATING WITH PRODUCTION SPEED

The RCA Vacuum Unit combines operating speed (only 7 minutes to 0.1 micron Hg) with electro-magnetic valving which eliminates heating and cooling delays of thermal pumps—permits immediate reopening, fast recycling. Completely interlocked for safety and equipped with 3 pairs of filament supports and an eighteen-inch bell-jar, the RCA Vacuum Unit is widely used for coating lenses, crystals, and plastics.

AVAILABLE FROM STOCK

RCA Vacuum Units are quantity produced for stock, eliminating the delays normally associated with custom-built equipment.

NATION-WIDE SERVICE

Complete maintenance contracts for RCA Vacuum Equipment—covering installation, regularly scheduled check-ups, emergency service, and parts replacement—are available through the RCA Service Company, a nation-wide organization of highly skilled electronic specialists.

For INFORMATION on RCA vacuum systems—or any member of the RCA Scientific Instrument family—write today to Scientific Instruments, Dept. 72J, Radio Corporation of America, Camden, N.J.

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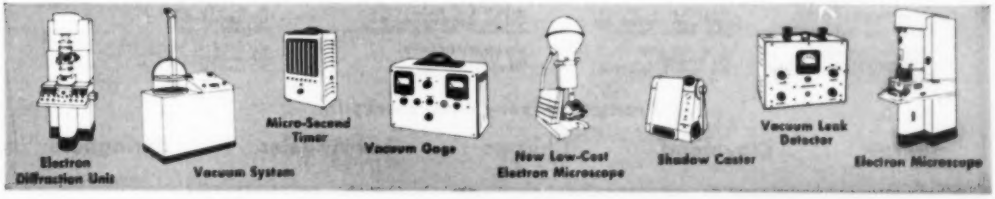

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Salt Baths for All Heat Treating Jobs from 300° F. to 2500° F.

Neutral Hardening • Liquid Carburizing • Tempering
Annealing—Ferrous and Non-Ferrous • Austempering and Martempering
Liquid Nitriding • High Speed Hardening • Pre-Heat and Quench Salts
Copper & Silver Brazing • Metal Blackening—Steel - Copper & Brass - Zinc

For Maximum Economy and Service Life . . . Investigate and Use

HEATBATH

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Originators of the PENTRATE PROCESS
Famous Black Oxide Finish for Iron and Steel

29 Years of Service to Industry

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CONFIDENTIAL SESSIONS

REFRACTORY MATERIALS FOR HIGH TEMPERATURES

You are cordially invited to make application to attend the two-day confidential conference on Refractory Materials for High Temperatures to be held under the auspices of the American Society for Metals at the Carter Hotel, Cleveland, Ohio, on

Monday, November 24, 1952
Tuesday, November 25, 1952

This meeting is held to provide an opportunity for the presentation and discussion of classified information that qualified engineers need to know in the performance of their jobs and in the best interests of national defense.

The preliminary program for this meeting is outlined on the next page. The variety of the subjects listed and the high qualifications of the speakers are assurance that the program will be an outstanding success.

This conference, while under the auspices of the ASM, is not limited to ASM members but to all individuals who can comply and who file in advance security qualifications.

Security regulations require that attendance at this meeting must be limited to citizens of the United States who possess evidence of current clearance through "confidential" by the Air Force, Navy, Research and Development Board, Atomic Energy or other credited United States Government agency.

To attend, the application form on p. 315 must be filled out and returned to the ASM headquarters in Cleveland through the military security officer having cognizance over the plant or activity and contract with which you are connected.

Once admission has been secured to the meeting room at the Carter, Security Authorities will require anyone leaving and re-entering to prove his clearance identity. Therefore, it has been arranged that luncheon will be served on Monday and Tuesday in the room adjoining the conference room. However, the meeting will be adjourned for dinner on Monday, between the afternoon and evening sessions. Luncheon will be served on Tuesday after the morning session and before the inspection trip at N.A.C.A.

ENROLLMENT FEE

Enrollment fee will be $10.00. This will include two luncheons and gratuities plus transportation to and from N.A.C.A. Laboratory and the Hotel Carter.

HOTEL RESERVATIONS

Those attending the conference are requested to make their hotel reservations direct with Miss Betty Maus, Reservation Manager, Hotel Carter, 1012 Prospect Avenue, Cleveland 15, Ohio, indicating the type of accommodations required and the date of arrival. The rates are as follows:

SINGLE					TWIN			
$4.00	$5.00	$6.50	$7.00	$7.50	$8.00	$9.00	$10.00	$11.00
DOUBLE					**SUITES**			
$6.00	$7.00	$8.50	$9.00	$9.50		$20.00	$30.00	

SEE PROGRAM NEXT PAGE

ASM Preliminary Program

REFRACTORY TYPE MATERIALS FOR HIGH TEMPERATURE APPLICATIONS

NOVEMBER 24 and 25, 1952

MORNING SESSION - NOVEMBER 24
(9:30 A.M. - 12:00 Noon)

Main Subject: *Molybdenum and Its Alloys*

Arc Cast Molybdenum and Molybdenum-Base Alloys—Their Manufacture, Fabrication and Properties—R. M. Parke, General Electric Co. (10 min.)

Sintered Molybdenum and Molybdenum-Base Alloys—Their Manufacture, Fabrication and Properties—By Howard Scott, Westinghouse Electric Co. (10 min.)

Related Discussion (5 min. each)

(a) L. F. YNTEMA, Fansteel Metallurgical Corp.
(b) H. HANICK, Wright Aeronautical Co.
(c) K. DIKE, NACA

Panel Session on Above Subjects* (30 Minutes)

The Elevated Temperature Properties of Molybdenum and Molybdenum-Base Alloys—By Howard Cross, Battelle Memorial Institute. (10 min.)

Protective Coatings for Molybdenum or Molybdenum-Base Alloys—By Ralph Wehrmann, Fansteel Met. Corp. (15 min.)

Related Discussion (5 min. each)

(a) K. M. BARTLETT, Thompson Products, Inc.
(b) D. G. MOORE, Bureau of Standards
(c) R. I. JAFFEE, Battelle Memorial—(Cladding)

Panel Session on Above Subjects* (30 Minutes)

— Recess 12:00 o'clock —

AFTERNOON SESSION - NOVEMBER 24
(1:30 - 5:00 P.M.)

Main Subject: *Ceramics and Intermetallics*

Ceramic Bodies for Use at Elevated Temperatures and Their Evaluations—By R. F. Geller, Bureau of Standards. (15 min.)

Related Discussion (5 min. each)

(a) F. K. DAVEY, Rutgers University
(b) G. M. BUTLER, Carborundum Co., or staff member
(c) TOM SHEVLIN, Ohio State University
(d) S. H. STUPAKOFF, Stupakoff Ceramic & Mfg. Co.
(e) N. P. THIELKE, Pennsylvania State College
(f) H. Z. SCHOFIELD, Battelle Memorial Institute

Panel Session on Above Subjects* (30 Minutes)

Intermetallics—New Type Refractory Alloys—By Louis Marchi or staff member, Armour Res. Foundation. (15 min.)

Molybdenum Disilicide, Properties at Elevated Temperatures —By W. Maxwell, NACA. (10 min.)

Titanium Disilicide, Properties at Elevated Temperatures—By R. Long, NACA. (10 min.)

Combinations of Carbides and Borides—Powder Ceramics—By Dr. Gordon Findley, Norton Co. (10 min.)

Related Discussion (5 min. each)

(a) R. SEELIG, American Electro Metals
(b) F. V. LENEL, R.P.I., Application of the Electrical Sintering Method to the Preparation of Ceramics and Intermetallics

Panel Session on Above Subjects* (30 Minutes)

EVENING SESSION - NOVEMBER 24
(8:00 to 10:00 P.M.)

Main Subject: *Uses and Application of Refractory Type Materials*

Problems Relating to the Usage of Refractory Materials in High Temperature Applications—By J. B. Johnson and/or R. Paris. WADC. (15 min.)

Turbine Operation with Refractory Type Materials—By G. C. Duetsch, NACA. (15 min.)

Related Discussion (5 min. each)

(a) W. R. SHERIDAN, Bell Aircraft (Rocket Nozzles)
(b) R. THIELEMANN, Pratt & Whitney Aircraft
(c) E. PEKAREK, Thompson Products
(d) S. MANSON, NACA, Thermal Shock

Panel Session on Above Subjects* (60 Minutes)

MORNING SESSION - NOVEMBER 25
(9:00 A.M. - 12:00 Noon)

Main Subject: *Ceramics and Intermetallics with Metal Additions*

Chairman: Dr. J. T. Norton, Massachusetts Institute of Technology

Theoretical Structure of Refractory Materials for Elevated Temperature Applications—By John T. Norton. (15 min.)

Additions of Metals or Alloys to Base Ceramic Type Materials —By Tom Shevlin, Ohio State University. (10 min.)

Infiltration of Intermetallic Type Bodies—By Claus G. Goetzel, Sintercast Corp. (10 min.)

Related Discussion (5 min. each)

(a) R. GURNICK, NACA
(b) J. R. TINKELPAUGH, N. Y. State College of Ceramics
(c) H. R. SPENDELOW, JR., Union Carbide and Carbon
(d) D. BENNETT, University of Illinois

Panel Session on Above Subjects* (30 Minutes)

New Developments on Titanium Carbide Compositions and Properties—By J. C. Redmond, Kennametal, Inc. (15 min.)

Elevated Temperature Properties of Zirconium Boride Alloys —By Frank W. Glaser, American Electro Metals (10 min.)

Alloys of Molybdenum Disilicide—By H. A. DeVincentis, NACA. (10 min.)

Related Discussion (5 min. each)

(a) R. WEHRMANN, Fansteel Metallurgical Corp.
(b) R. B. FISCHER, Battelle Memorial Institute
(c) W. L. HAVEKOTTE, Firth-Sterling Steel Co.
(d) J. J. HARWOOD, Office of Naval Research

Panel Session on Above Subjects* (25 Minutes)

Session Closes at 12:00 Noon

Lunch to 1:30

Tour and Inspection of NACA, Lewis Flight Propulsion Laboratory at 2:15 - 4:30 P.M.

Panel sessions will be made up of chairman as moderator and all speakers.

ATTEND TO THIS TODAY →

IMPORTANT: TO BE RETURNED TO ASM VIA MILITARY SECURITY OFFICER ONLY

Request for Clearance to Attend the

CONFIDENTIAL SESSION ON

"REFRACTORY-TYPE MATERIALS FOR HIGH-TEMPERATURE APPLICATIONS"

Sponsored by the American Society for Metals

MONDAY AND TUESDAY, NOVEMBER 24 and 25, 1952

HOTEL CARTER—RAINBOW ROOM

CLEVELAND, OHIO

American Society for Metals
7301 Euclid Avenue
Cleveland 3, Ohio

ATTENTION: Refractory Materials Committee

Gentlemen:

TO BE FILLED OUT BY APPLICANT

Clearance is requested to attend the above confidential session.

Applicant's Name (print) _____

Birthplace _____ Citizenship _____

If birthplace not U. S., give details _____

_____

Company Affiliation and Address _____

_____

Applicant's Title or Position _____

Applicant's Home Address _____

If you have already been cleared for access to CONFIDENTIAL or higher classification of information, please specify

_____
(Air Force, Navy, Research and Development Board, Atomic Energy, etc.)

on _____ in connection with _____
(date) (project or contract number, etc.)

_____

This request is based upon my need to know the information and material to be discussed at this meeting as necessary in the performance of my work and in the best interest of the military or other government services.

DATE _____ APPLICANT'S SIGNATURE _____

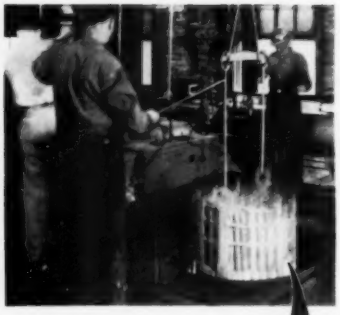
TO BE FILLED OUT BY MILITARY SECURITY OFFICER

I hereby confirm clearance of this applicant as indicated above.

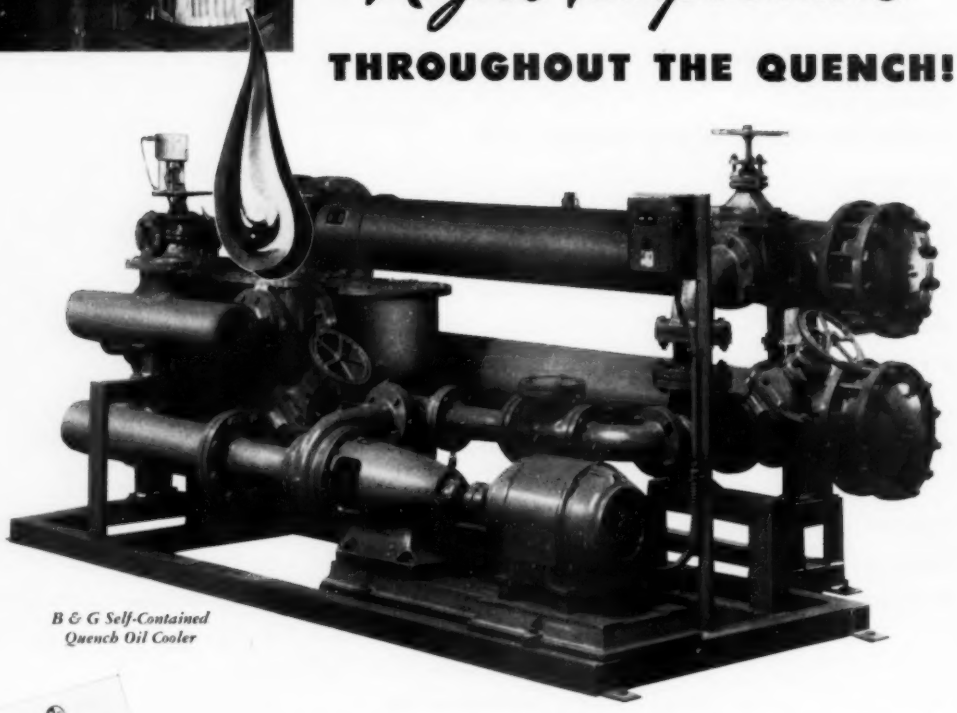
DATE _____ (SIGNED) _____
(Military Security Officer having cognizance over applicant's plant or activity and contract)

THIS FORM MUST BE RETURNED **ON OR BEFORE NOVEMBER 15, 1952, VIA MILITARY SECURITY OFFICER** (Navy, Air Force, Research and Development, Atomic Energy, etc.) HAVING COGNIZANCE OVER THE APPLICANT'S PLANT OR ACTIVITY AND CONTRACT.

Security Officer:—When request for clearance has been approved, please mail direct to
American Society for Metals, 7301 Euclid Ave., Cleveland 3, Ohio



EVERY DROP OF OIL AT THE *Right Temperature* THROUGHOUT THE QUENCH!



B & G Self-Contained Quench Oil Cooler

This combined Catalog and Selection Manual gives full information.

Old-fashioned, uncontrolled quenching methods may be costing you more than you realize. By installing a B & G *Hydro-Flo* Quench Oil Cooling System you can eliminate losses caused by excessive rejects—make an "inside profit" by cutting operating costs.

The "SC" Series *Hydro-Flo* Oil Cooler is completely self-contained—combining Cooler, Motor, Pump, Strainer and all controls in a single, integrated unit. Fully automatic, it keeps oil temperature at the desired degree through all stages of the quench.

Or, if you prefer, the component parts of a *Hydro-Flo* Oil Cooling System may be purchased and assembled on the job. In either case, you are assured of *uniform quality* in your product because of *uniform quenching conditions.*

Send for Catalog and Simplified Selection Manual.

SEE B & G HYDRO-FLO QUENCH OIL COOLERS AT BOOTH 1772 NATIONAL METAL EXPOSITION

BELL & GOSSETT
COMPANY
Dept. CR-16, Morton Grove, Ill.

Canadian Licensee: S. A. Armstrong Ltd., 1400 O'Connor Drive, Toronto, Canada

Now!

TOCCO* Induction Melting Furnaces for Precision Casting

One of the TOCCO Induction Melting Furnaces used at Arwood Precision Casting Co. Note TOCCO control station in background.

● Engineers at Arwood Precision Casting Co. use TOCCO Induction Melting Furnaces for melting and remelting quality steel. Other companies have found TOCCO equally adaptable for melting non-ferrous metals. No wonder! *Look at the advantages:*

- ★ Stepless power control
- ★ Extremely Rapid Melting
- ★ High Efficiency on Intermittent Operation
- ★ Good Mixing because of Natural Agitation
- ★ Extremely Low Alloy Loss
- ★ No Carbon Pick-up
- ★ No Contamination when Composition of Charges is Changed
- ★ High Reproducibility of Results
- ★ Minimum Space Requirements
- ★ No Special Installation Charge
- ★ Simple, Safe Operation
- ★ Clean, Comfortable Working Conditions

If any of these advantages suggest economies in your operations write for full details—no obligation, of course.

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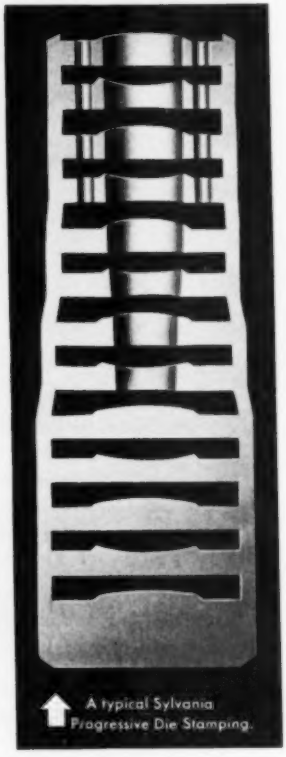
TOCCO

Induction Heating Equipment must meet the requirements of the Federal Communication Commission's Rules and Regulations Relating to Industrial, Scientific and Medical Services, Part 18. All TOCCO equipment is certified to comply with these rules and regulations.

Tailor-made parts in BIG VOLUME at BIG SAVINGS

Highly trained Sylvania tool-and-die maker checking tolerance of die-stamped part. Because presses operate automatically, operators can make 10 to 20% work checks.

A finished part for an electronic tube, turned out at the rate of 4800 per hour.



A typical Sylvania Progressive Die Stamping.

Modern Sylvania methods speed your parts production . . . give closer tolerances . . . save you money!

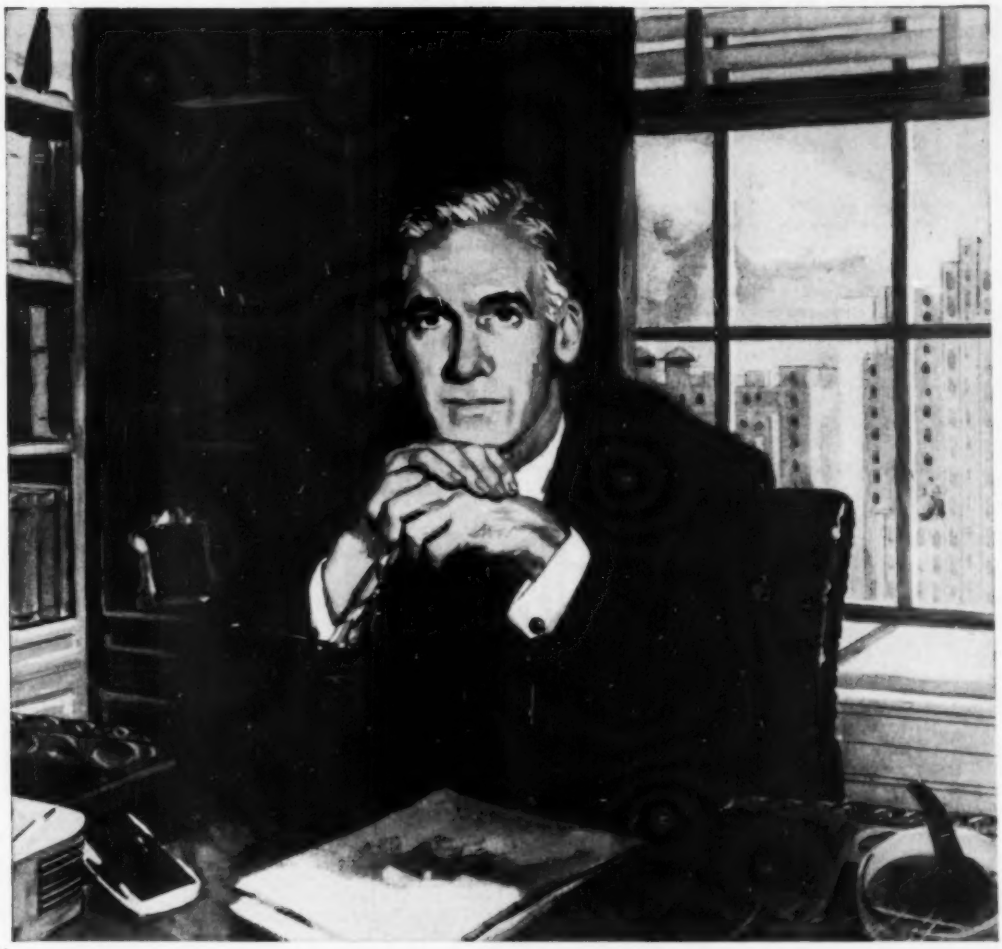
In producing highly critical parts for electronic tubes, Sylvania Tool and Die Makers eliminated 5 separate operations and supplied twice as many parts in a given time.

In addition to high speed, the *quality* of the parts was greatly improved and tolerances were consistently held within satisfactory limits.

This example of excellent parts engineering and economy is being repeated over and over again by Sylvania's versatile cutting and stamping methods. Find out what this can mean for you! No matter what type of product for which you need parts we welcome your inquiries. ***As the first step in the solution of your parts problems, write today to: Sylvania Electric Products Inc., Parts Division, Dept. A-1710, Warren, Pa.***

SYLVANIA

RADIO TUBES; TELEVISION PICTURE TUBES; ELECTRONIC PRODUCTS; ELECTRONIC TEST EQUIPMENT; FLUORESCENT TUBES, FIXTURES, SIGN TUBING, WIRING DEVICES; LIGHT BULBS; PHOTOLAMPS; TELEVISION SETS



plenty of reason to set you dreaming

This is a time for planning, by business men of vision. The day must come when allocations and priorities will be words of the past . . . when materials will be much easier to get and orders perhaps much harder. Against that day, let some of your dreaming center on stainless steel, the most uniquely useful metal in the book—hard, strong, beautiful, everlasting.

● Our Development Engineers and Research Staff are at your service. Let us work with you. ***Allegheny Ludlum Steel Corporation, Oliver Building, Pittsburgh 22, Pa.***

You can make it **BETTER** with

Allegheny Metal

AL
TIME-TESTED STAINLESS STEEL

VSD 4016

the new OLSEN DE LUXE MODEL "SUPER L"

industry asked for it

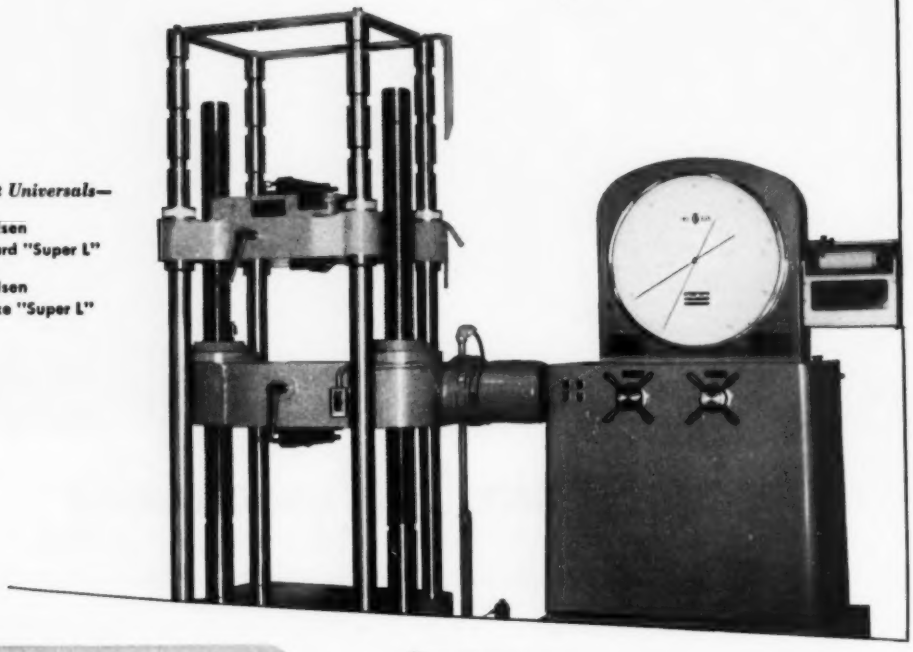
here is real flexibility

- Thirty inch (30") clearance between screws—easy to work with large specimens. Rugged four-column construction—rigidity for off-center loads and high columns.
- Loading and weighing units independent of each other—no shock transfer.
- Increased stroke length, and higher columns—test larger specimens.
- Upper crosshead easily positioned—handle various sizes and length of specimens. Separate motor control for upper crosshead—additional controls on crosshead for convenience.
- Fool-proof SelecTrange Indicating System—load range selected is automatically color lighted to match colored divisions on 28" dial. Soft-view indirect dial lighting.
- 50 to 1 ratio of testing ranges. (100 to 1 with Olsen Electronic Recorder.)
- Exclusive atcotran electronic null weighing system.
- Change ranges at flip of a switch while under test.
- 200,000 lb. and larger machines designed so floor line can be on table line or as desired.
- Available in 60,000 lb.; 120,000 lb.; 200,000 lb.; 300,000 lb.; 400,000 lb.; 500,000 lb ; and 600,000 lb. capacities.

Two Great Universals—

The Olsen Standard "Super L"

The Olsen De Luxe "Super L"



Olsen 400,000 lb. De Luxe Model "Super L".

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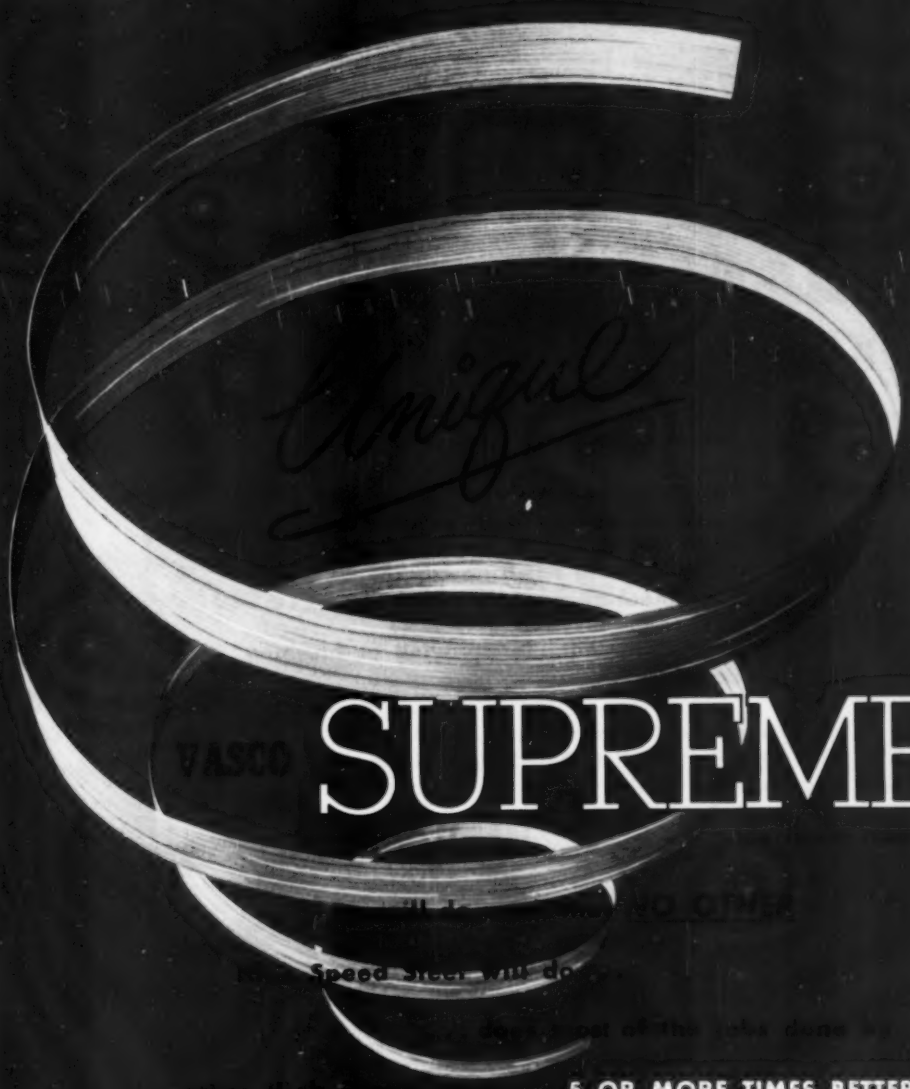
Write today for full details.



SUPREME

5 OR MORE TIMES BETTER!

Vanadium-Alloys

LATROBE, PA.

TAM* ZIRCONITE*

ALL-PURPOSE PASTE WASH

Outstanding results are reported for TAM ZIRCONITE Paste Wash in diversified applications by many leading foundries:

CORE MUD...to prevent metal cutting into joints between core halves (slightly thinned).

CORE PATCHING...to patch up cracked or broken cores (without diluting).

CORE WASH...for dipping, spraying or brushing cores in green or baked state.

Among important advantages...any washing solution made from TAM ZIRCONITE Paste Wash can be used ***immediately after preparation.*** Resistance to settling eliminates need for constant agitation.

Because of the multiple bonding agents used, it remains on core or mold without peeling, checking or spalling throughout baking and pouring operations.

For detailed information, write our New York City office. Supplied in easily-handled steel drums of various sizes.

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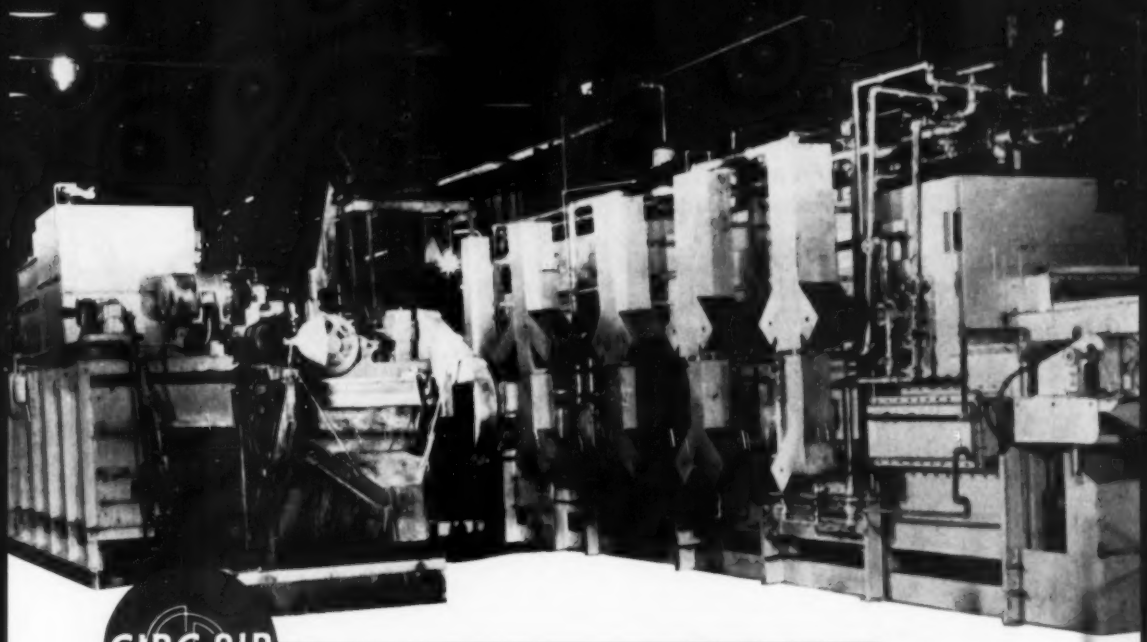

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Continuous CLEAN HARDEN QUENCH WASH CIRC-AIR DRAW AND SOLUBLE DIP...

Capacity 1500#/hr. — Bolts, Nuts, Miscellaneous Similar Parts, Automatic Metering Feed Hardening and Draw Furnaces, both Recirculating, Propeller Agitated Quench. Uniform Distribution of Stock on Wash and Draw Belts around 90° Turn by Means of Unique Stock Dispersal Units.

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INDUSTRIAL HEATING EQUIPMENT CO.

Manufacturers of Industrial Furnaces and Oil Burners Since 1917

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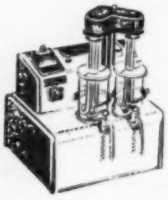
fabulously fast
metal separation by
DYNA-CATH mercury cathode



New design makes mercury cathode a practical analytical tool. Dyna-Cath does a fast, complete job in separation of metals. Particularly valuable in determination of aluminum in steel and zinc base alloys, other separations. Ask for Bulletin 220-F for details.

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SCIENTIFIC INSTRUMENTS & APPARATUS
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. . . and see how a blank is made into a half-tank section in 20 seconds by the SCHNELL patented deep drawing die process. . . .

This half-tank section, 14½ inch diameter by 24 inches deep, was drawn from a 38½-inch blank . . . 0.105 inch thick in 20 seconds. Formerly these half-tanks required three drawing and two annealing operations with scrap running as high as 50%. Scrap has been reduced to 1% or less and production increased tremendously.

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ELECTRIC MELTING FURNACE

. . . as ever, the dependable furnace for the production of high-grade stainless, alloy and rimming steels.

Removable roof of new design now available for the larger furnaces.

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Precision Investment
CASTING

As pioneers of this new improved foundry process now being used extensively in many industries for the production of metal parts, we invite you to consult us to learn how precision investment casting can be of material assistance to you.

Call on us for complete equipment, all operating supplies and advice on applying this process.

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SAFETY SWITCH
THAT SHUTS OFF FUEL IF BLOWER FAILS

Protection for Oil Burners
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Industrial Ovens
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Power Gas Burners

WHAT IT DOES

The Dewey Safety Air-flow Switch protects against opening of fuel valve until fan is up to speed.

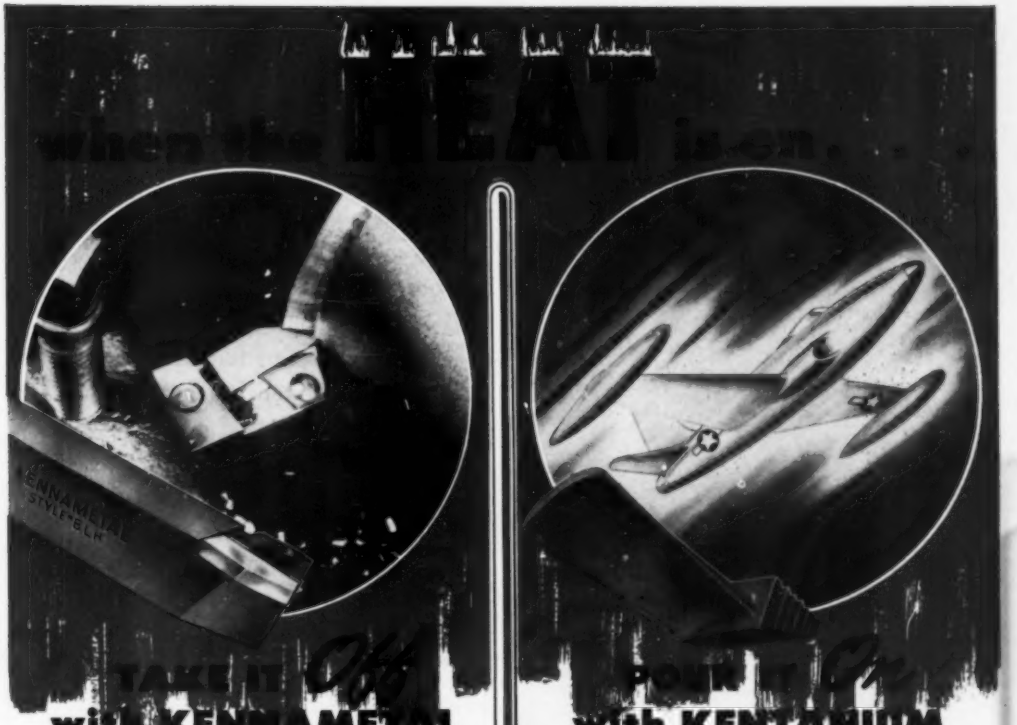
Insures purging of furnace before fuel valve opens. Closes fuel valve if fan slows up or stops. Flashes danger signal if fan or fuel stops. Safeguards against danger from gas fuel failure when used in connection with safety shut-off valve.

Thousands sold. Factory Mutual and Underwriters Laboratories Approved. Standard equipment on leading products. Write for prices and literature.

DEWEY GAS FURNACE CO.
102 E. Baltimore Detroit 2, Mich.

FREE CIRCULAR

Dewey SAFETY AIRFLOW SWITCH



TAKE IT OFF with KENNAMETAL

When the metal-cutting job is rugged — specifications precise — delivery schedule tight — use Kennametal tooling to "take off the heat".

Kennametal tools are remarkably hard, strong, and tough. They stay on the job longer . . . require fewer trips to the grinding room. Idle machine time is minimized . . . skilled operators work to best advantage . . . tooling costs drop—and productivity rises through higher speed and heavier feeds.

Kennametal gives this superior performance — consistently — because its physical structure is sound and uniform — a characteristic which is imparted and maintained by distinctive processes under the direction of men who know carbides from "the ground floor, on up".*

Men — with technical "know-how" — make Kennametal an outstanding tool material. And — the skilled men who operate and are in charge of metal-cutting machines fully realize its plus-value when "the heat is on".

POUR IT ON with KENTANIUM

When there is urgent need for a material having longer service life and improved performance under high temperatures — Kentanium offers outstanding advantages.

It has much better stress rupture characteristics than conventional alloys even at 1600°F, a superiority that becomes more pronounced as temperatures increase. From 1800°F to 2200°F, for long periods, and up to 4500°F for short exposures, it withstands oxidation while retaining unusually high strength, and shows no weakening under thermal shock.

Much lighter than steels and conventional alloys, it presents design and operating advantages, particularly for rotating, or reciprocating parts.

Kentanium is suitable for: gas turbine components, valves and seats for gas engines, hot spinning tools, hot extrusion dies, and many other applications. If your design problem involves high temperature conditions, let us demonstrate how you can safely "pour on" more heat when structural elements are made of Kentanium.*

KENNAMETAL

**Kennametal Inc. mines basic raw materials, refines all its carbides directly from ores, oxides, and by-products, processes these carbides into Kennametal compositions . . . then engineers and fabricates complete tools and wear-part designs that fully utilize the distinctive properties of Kennametal.*

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SUPERIOR CEMENTED CARBIDES
KENNAMETAL Inc. LATROBE, PA.

KENTANIUM

**Kentanium—developed and produced exclusively by Kennametal Inc.—is chiefly titanium carbide with nickel as auxiliary metal (no tungsten or cobalt). Made in several different compositions to meet varying conditions. Available as standard extruded shapes . . simple molded forms . . intricate designs.*

See Kentanium Demonstrations — Space 1319 — National Metal Exposition

Brackets can be furnished for attaching furnace to column as shown above.
Tensile test type of Marshall furnace is shown at right.

Laboratories of the stainless steel industry, automotive and aircraft industries, metal refining, and atomic energy research are all users of the Marshall tubular furnace for tensile, creep or stress-rupture tests.

These research engineers express a high degree of satisfaction with the results of using this equipment. They find that temperature of the heating chamber in Marshall furnaces can be maintained with a uniformity within plus-or-minus 3° F. and in some cases within 1° F. Furnaces are available in "Creep Test" type and "Tensile Test" type. Write for literature.

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270 W. Lane Ave., Columbus 2, Ohio

Marshall furnaces

AND CONTROL PANELS

METALLURGIST

Graduate Engineer, 3 to 5 years experience in the heat-treatment, metallography, and physical testing of ferrous materials, for position as Group Leader in modern metallurgical laboratory. Company-furnished meals, insurance, hospitalization and medical care. Liberal vacation policy. Plant location Cleveland suburb, close to good residential areas. Outline experience and minimum salary requirements in letter. Write Dept. 3261-25.

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To help you with any technical problems, the facilities of our plant are available. Just give us a call at our office,
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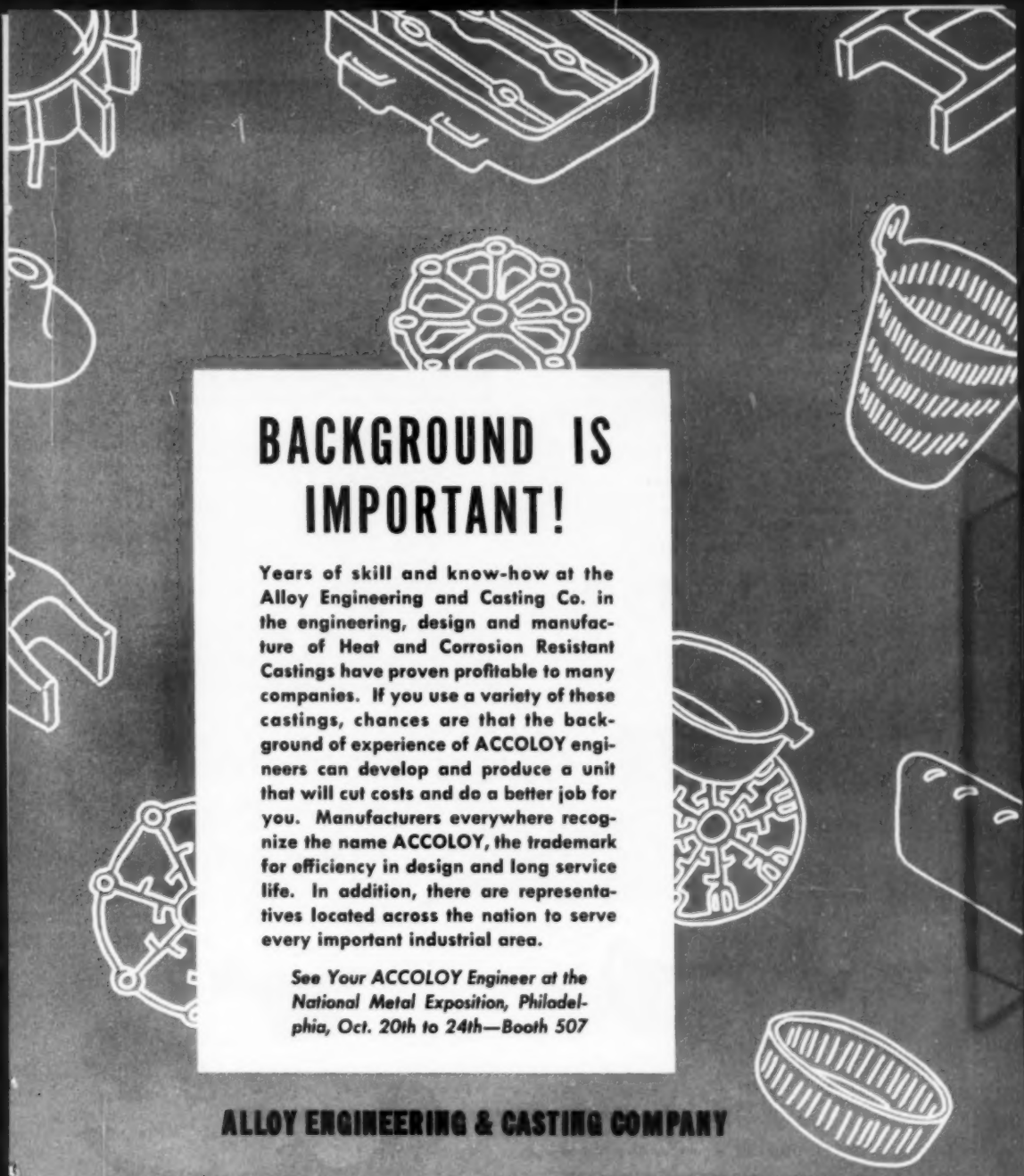

BACKGROUND IS IMPORTANT!

Years of skill and know-how at the Alloy Engineering and Casting Co. in the engineering, design and manufacture of Heat and Corrosion Resistant Castings have proven profitable to many companies. If you use a variety of these castings, chances are that the background of experience of ACCOLOY engineers can develop and produce a unit that will cut costs and do a better job for you. Manufacturers everywhere recognize the name ACCOLOY, the trademark for efficiency in design and long service life. In addition, there are representatives located across the nation to serve every important industrial area.

See Your ACCOLOY Engineer at the National Metal Exposition, Philadelphia, Oct. 20th to 24th—Booth 507

ALLOY ENGINEERING & CASTING COMPANY

HEAT RESISTANT CASTINGS
ACCOLOY
STAINLESS STEEL CASTINGS

ALLOY CASTING CO. (DIVISION)
CHAMPAIGN, ILLINOIS

ENGINEERS AND PRODUCERS OF HEAT AND CORROSION RESISTANT CASTINGS

KING PORTABLE BRINELL

HARDNESS TESTER

Eliminates excessive material handling costs in routine and special Brinell hardness testing. The King Portable Brinell can be carried to the work, used in any position, and always puts an actual load of 3000 kg. on the 10-mm. ball indenter.

This 27-lb. portable tester has a 4-in. deep throat and a gap 10 in. high. For larger pieces, the test head is easily removable for testing sections beyond the capacity of the standard base.

Throat—4" deep. Gap—10" high. Weight—27 lbs.

Simple to operate, the tester is impossible to overload, and even with inexperienced operators will provide consistent accurate results well within the requirements of the Bureau of Standards.

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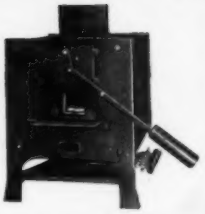
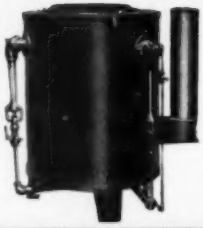
"BUZZER" HIGH SPEED *Gas* FURNACES

2400° F.
attained quickly with "BUZZER" High Speed Full Muffle Furnaces.

Designed primarily for high carbon and alloy steels.



NO BLOWER or POWER NECESSARY
. . . Just connect to gas supply



"BUZZER" Atmospheric Pot Hardening Furnaces assure even heat up to 1650° F.
Used for Salt, Cyanide and Lead Hardening. Also adapted for Melting Aluminum.

Send for the complete "BUZZER" catalog today.

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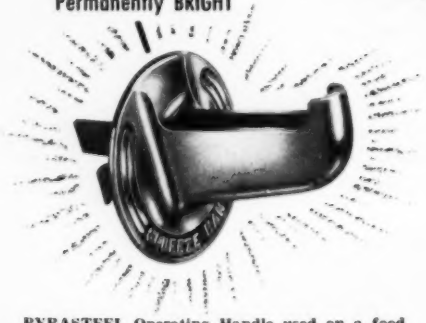
PYRASTEEL *Alloy* Steel PARTS
for producing a lasting finish

Permanently BRIGHT



PYRASTEEL Operating Handle used on a food vending machine.
The manufacturer tried a number of materials, but the handle would soon become discolored from use.
Then PYRASTEEL was employed for casting these units—result: the highly polished surface remains impervious to stain or wear under all conditions of service.

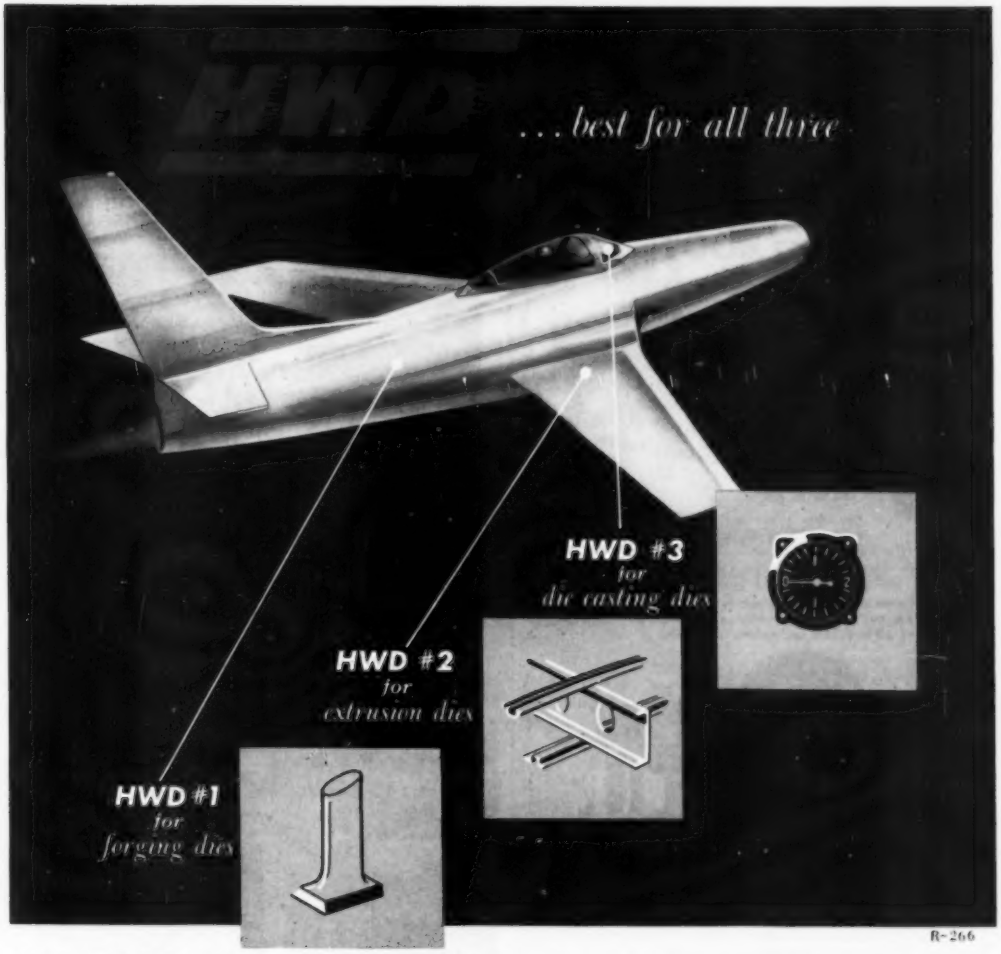
Write for PYRASTEEL Bulletin

Permanently SANITARY

PYRASTEEL Stainless Parts are essential in many applications for modern food processing equipment.

CHICAGO STEEL FOUNDRY COMPANY

Kedzie Avenue and 37th Street, Chicago 32, Ill. • ***Makers of Alloy Steel for Over 40 Years***



R-266

Firth Sterling's HWD steels, because of their versatility in forging dies, extrusion dies, and casting dies, are fast becoming the popular choice throughout the industry. Here are six very important reasons why:

(1) Longer die life is assured because HWD steels maintain their *hardness.*

(2) Cracking is greatly minimized because of HWD's exceptional *toughness.*

(3) HWD steels have real resistance to "*washing*" in die casting operations.

(4) A thorough series of *inspections,* including ultrasonic testing, insures the very best in top *quality* steel.

(5) Air hardening insures *minimum movement* in heat treatment.

(6) Balanced alloy composition provides exceptional resistance to *checking or cracking* when the steel is cooled by water.

HWD Comes in Three Grades

HWD #1 and #2 are essentially the same steel except that HWD #2 has no tungsten, giving it more resistance to thermal shock. HWD #3 is Firth Sterling's latest modification of HWD #2 and has a higher Vanadium content to increase the life of die casting dies.

See us at the Metal Show—Booth 421

Firth Sterling INC

OFFICES* AND WAREHOUSES: HARTFORD NEW YORK* DETROIT CLEVELAND DAYTON* PITTSBURGH* CHICAGO BIRMINGHAM* LOS ANGELES PHILADELPHIA*

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CHALLENGE
Precision
SURFACE PLATES
and Equipment

ON EXHIBIT AT **BOOTH 932**

NATIONAL METAL EXPOSITION
PHILADELPHIA — OCTOBER 20-24

Available either precision ground or planer finished, Challenge Layout Surface Plates offer a perfectly smooth, square surface for layout, inspection or assembly line operations. Sizes range from 12" x 18" to 54" x 144". All are built of special analysis semi-steel. The all-steel stand is arc-welded to furnish the rigidity of a one-piece unit. Special leveling screws enable the user to level the plate quickly and to lock it securely.

Semi-Steel
LAPPING PLATE

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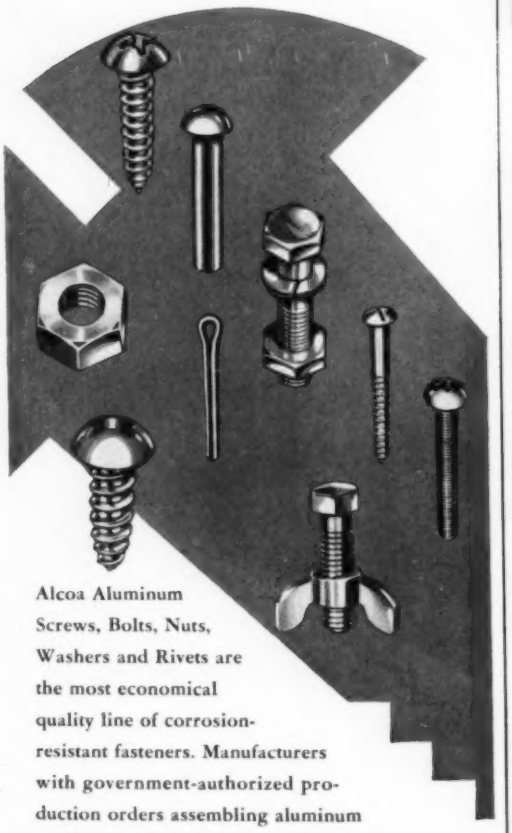

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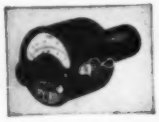

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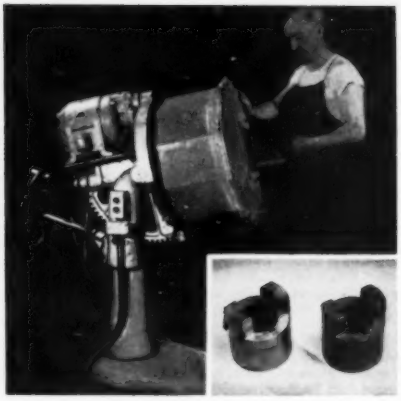

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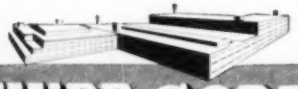

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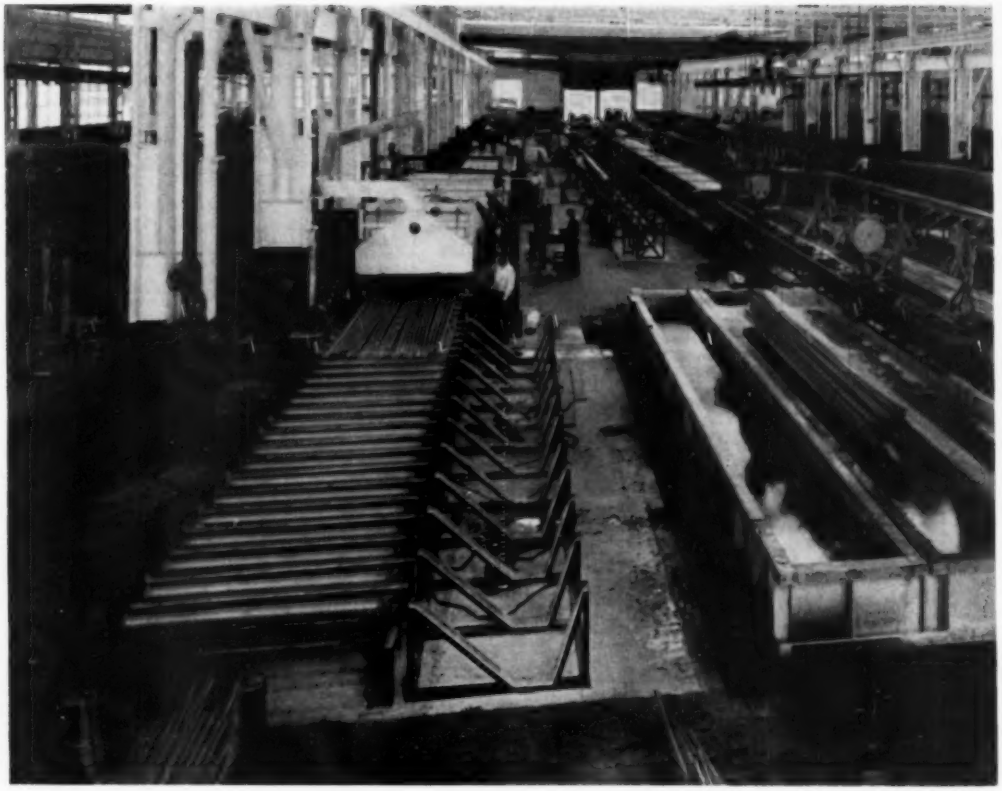

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